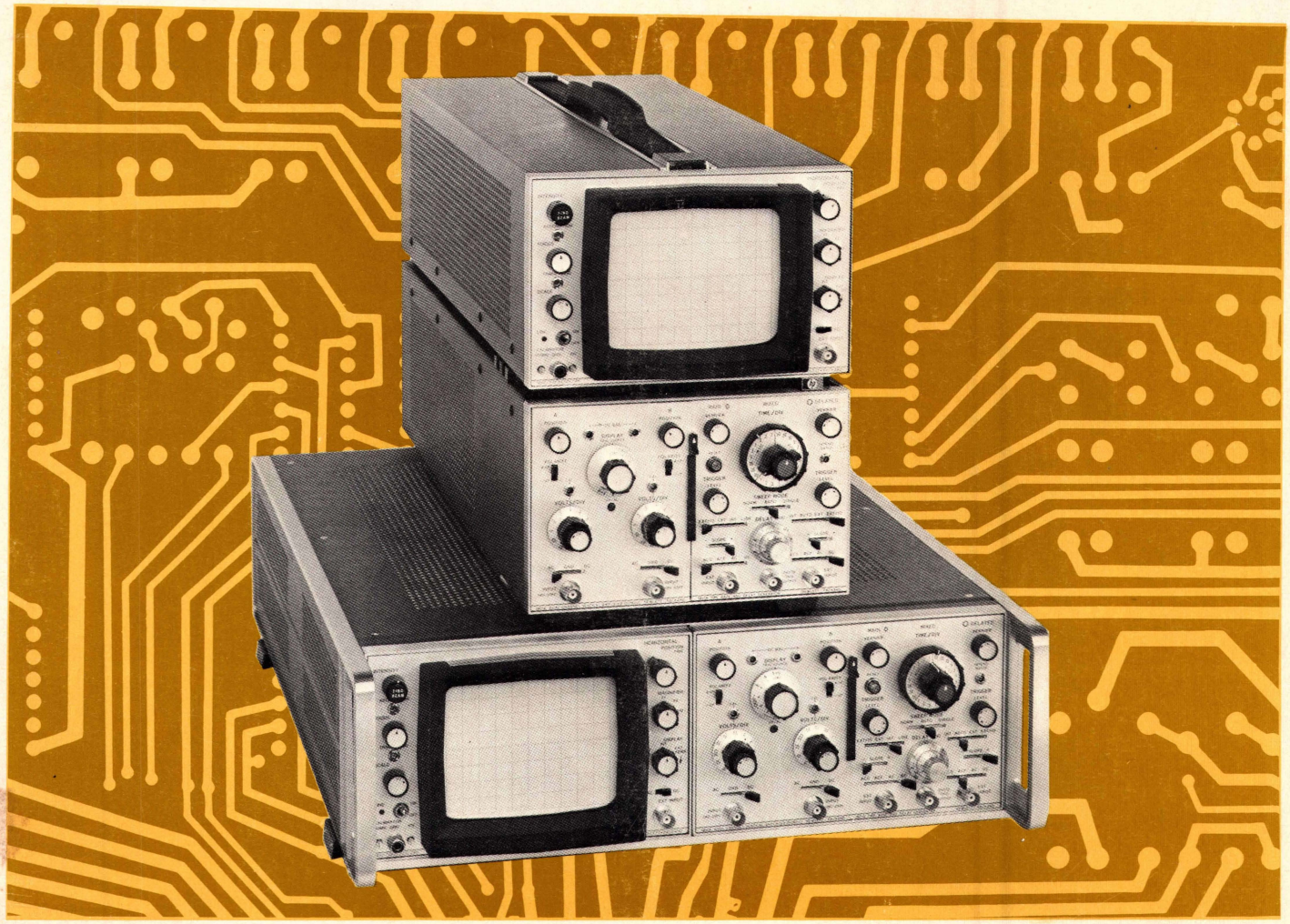

180T/TR
OSCILLOSCOPE

OPERATING AND SERVICE MANUAL

HEWLETT hp PACKARD

COLORADO SPRINGS DIVISION

CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

This Hewlett-Packard product is warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

C W&A 6/74

MANUAL CHANGES

MODEL 180T/TR

OSCILLOSCOPE

Manual Serials Prefixed: 1509A
Manual Printed: FEB 1975

Make all changes listed below as Errata. Check the following table for your instrument serial prefix and/or serial number and make listed change(s) to the manual:

Serial Prefix or Number	Make Changes	Serial Prefix or Number	Make Changes

ERRATA

Page 5-7, paragraph 5-32,
Add following note under step a:

NOTE

When Group B plug-in is installed, select single trigger.

Table 6-2,
A2R38: Change to HP Part No. 2100-1775, R:VAR WW 5K OHM 5% 1W, Mfr Code 28480, Mfr Part No. 2100-1775.
A3R51: Change to HP Part No. 0698-8018, R:FXD FLM 30 MEGOHM +1—19% 3W, Mfr Code 03888, Mfr Part No. PVC175-3-T0-3004-F.
A3R52: Change to HP Part No. 0687-1051, R:FXD COMP 1 MEGOHM 10% 1/2W, Mfr Code 01121, Mfr Part No. EB1051.
A3R57: Change to HP Part No. 0687-4721, R:FXD COMP 4700 OHM 10% 1/2W, Mfr Code 01121, Mfr Part No. EB4721.
Δ A3R58: Change to HP Part No. 0698-5353, R:FXD FLM 8.25 MEGOHM 5% 1W, Mfr Code 28480, Mfr Part No. 0698-5353.
Δ A3R59: Change to HP Part No. 0698-6580, R:FXD FLM 16.25 MEGOHM 5% 1W, Mfr Code 28480, Mfr Part No. 0698-6580.
Add: A3V1, HP Part No. 2140-0013, LAMP-GLOW T-2 BULB 57V, Mfr Code 08806, Mfr Part No. 5AB-A(NE-23A).
Add: A3V2, HP Part No. 2140-0013, LAMP-GLOW T-2 BULB 57V, Mfr Code 08806, Mfr Part No. 5AB-A(NE-23A).
Add: A3VR1, HP Part No. 1902-0025, DIODE-ZNR 10V 5% PD = .4W, Mfr Code 15818, Mfr Part No. CD35706.

Table 6-2 (Cont'd),
Add: A3VR2, HP Part No. 1902-0045, DIODE-ZNR 7.32V 2% PD = .4W, Mfr Code 15818, Mfr Part No. CB35668.
A5R1: Change to HP Part No. 0687-2231, R:FXD COMP 22K OHM 10% 1/2W, Mfr Code 01121, Mfr Part No. EB2231.

Δ Page 7-1,
Add paragraph 7-11 and 7-12 as follows:
7-11. OPTION 003. Model 180T/TR, Option 003 is the same as the standard instrument except that the standard low voltage power supply transformer has been replaced with one designed to operate from a source of 100V or 200V input power. Table 1 of this manual changes sheet lists parts changes for instruments using the Option 003 low voltage power module. The differences in the optional circuitry are shown in figure 1 of this manual changes sheet.
7-12. OPTION 580. This option replaces the instrument bottom covers with special covers that conform to CSA standards. Make the following changes to parts listed in table 6-2 for instruments equipped with Option 580:
a. MP4: Change HP Part No. and Mfr Part No. to 00180-64113.
b. MP5: Change HP Part No. and Mfr Part No. to 00180-64114.
c. MP76: Change HP Part No. and Mfr Part No. to 00180-64115.

Schematic 3,
A2Q3: Show symbol as pnp.

Page 8-16, figure 8-9,
VR3: Change reference designator to V1.
VR4: Change reference designator to V2.

Schematic 5,
A3R49: Change wiper to +100V instead of —100V.
A3R57: Change value to 4700 ohms.
A3VR3: Change reference designator to A3V1.
A3VR4: Change reference designator to A3V2.

12 January 1976
Δ = Latest additions to this change sheet.
This change sheet supersedes all prior change sheets for this manual.

Supplement A for
00180-90931

HEWLETT hp PACKARD

Table 1. Replaceable Parts Changes for Option 003

Action	Ref. Desig.	HP Part No.	TQ	Description
Change	A1	00184-60003 to 00180-60004	1	POWER MODULE: LOW VOLTAGE
Change	A1T1	9100-3401 to 9100-3249	1	TRANSFORMER: POWER
Change	A1A1	00184-66511 to 00182-66505	1	ASSY: LOW VOLTAGE RECTIFIER BOARD
Change	A1A1C1	0180-0091 to 0180-1811	1	C:FXD ELECT 100 UF +75–10% 20VDCW
Change	A1A1CR1 through A1A1CR4	1901-0028 to 1901-0049	4	DIODE: SILICON 0.75A 50 PIV
Change	A1A1R1 and A1A1R2	0687-1041 to 0757-0342	2	R: FXD MET FLM 100K OHM 1% 1/4W
Delete	A1A1R3			
Delete	A1A1R4			
Delete	A1A1VR1			
Change	A1A2	00184-66509 to 00182-66514	1	ASSY: LOW VOLTAGE REGULATOR BOARD
Change	A1A2C1	0140-0176 to 0160-2204	1	C: FXD MY 100 PF 5% 300VDCW
Change	A1A2Q1	1854-0234 to 1854-0039	1	TSTR: SI NPN 2N3053
Add	MP201	7120-4106	1	LABEL: CAUTION
Add	MP202	7120-4453	1	TAG: 100 VOLT

7000-A-15

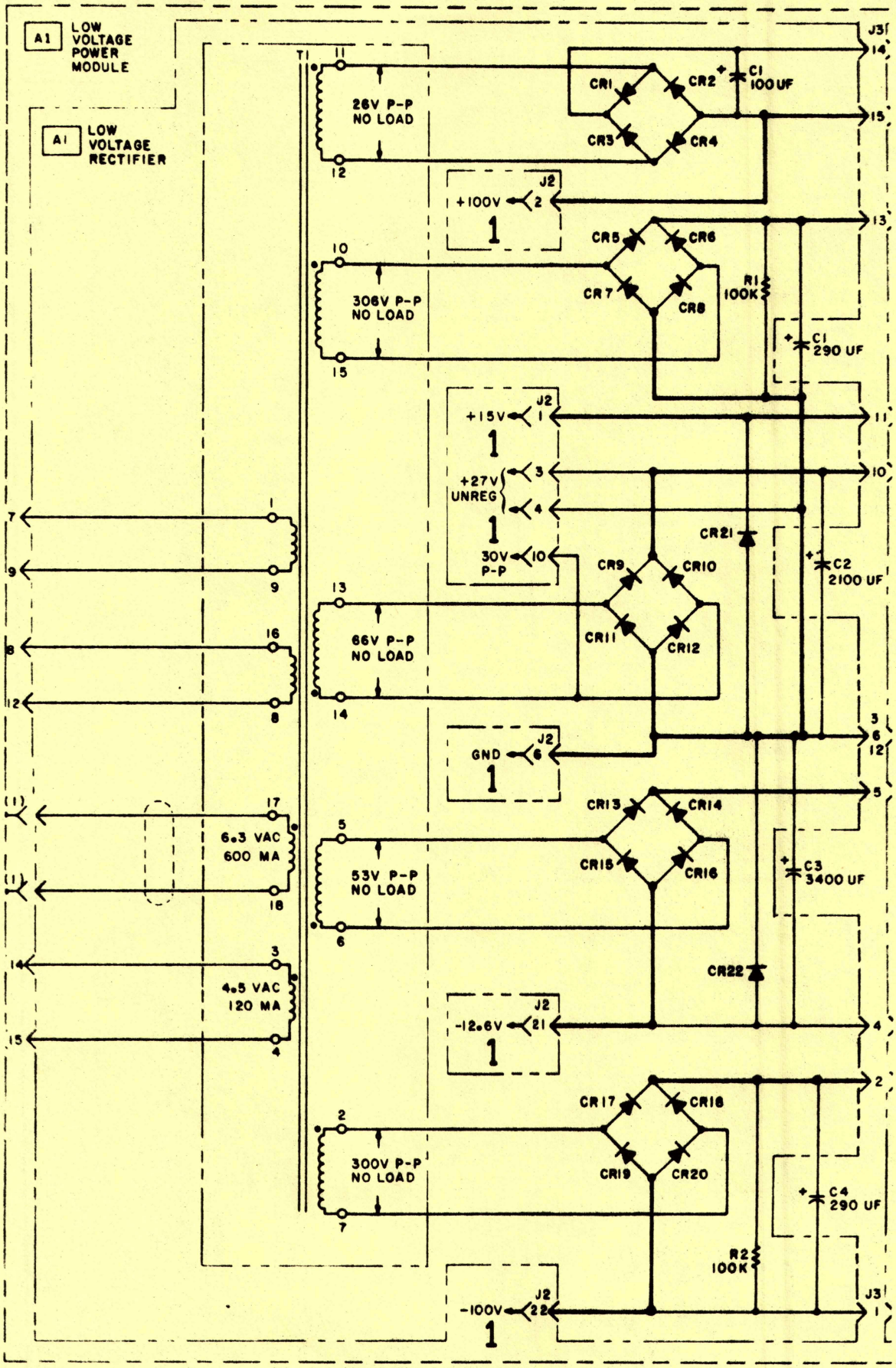

Figure 1. Special Schematic for Option 003

OPERATING AND SERVICE MANUAL

MODEL 180T/TR
OSCILLOSCOPE

SERIALS PREFIXED: 1509A

Refer to Section VII for instruments with other Serial Prefixes.

HEWLETT-PACKARD COMPANY/COLORADO SPRINGS DIVISION
1900 GARDEN OF THE GODS ROAD, COLORADO SPRINGS, COLORADO, U.S.A.

Manual Part Number 00180-90931
Microfiche Part Number 00180-90831

PRINTED: FEB 1975

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT.

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE.

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS.

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE.

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

USE CAUTION WHEN EXPOSING OR HANDLING THE CRT.

Breakage of the cathode-ray tube (CRT) causes a high-velocity scattering of glass fragments (implosion). To prevent CRT implosion, avoid rough handling or jarring of the instrument. Handling of the CRT shall be done only by qualified maintenance personnel using approved safety mask and gloves.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT.

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS.

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

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SECTION I

GENERAL INFORMATION

1-1. INTRODUCTION.

1-2. This manual provides operating and service information for Hewlett-Packard Models 180T and 180TR oscilloscope mainframes. The manual is divided into eight sections each covering a specific topic or aspect of the instrument. All schematics are located in Section VIII.

NOTE

This manual does not apply to the plug-ins. The appropriate plug-in Operating and Service Manuals should be referred to.

1-3. This section contains a description of Model 180T/180TR. Instrument specifications are listed in table 1-1. Table 1-2 lists abbreviations used throughout this manual, except in Section VI. The parts list in Section VI is a computer printout and uses computer-supplied abbreviations.

1-4. DESCRIPTION.

1-5. Models 180T and 180TR are general purpose oscilloscopes with plug-in capability. The instruments, as shipped from the factory, are intended for bench use. The Model 180TR can be rack mounted as described in Section II.

1-6. The mainframes are designed to operate with real time, sampling and TDR, and frequency domain plug-ins.

1-7. The horizontal amplifier has a direct-coupled bandwidth of dc to 5 MHz. The ac-coupled bandwidth is 5 Hz to 5 MHz with a dynamic range of ±20 volts. The amplifier has front-panel selectable deflection factor ranges of 1 V/div (X1), 0.2 V/div (X5) and 0.1 V/div (X10). A vernier control provides continuous adjustment between ranges. A front-panel BNC connector permits the use of external deflection signals. The external input impedance is 1 megohm shunted by approximately 30 pF.

1-8. A rear-panel BNC connector (Z-axis Input) is provided for external control of CRT blanking. A signal of approximately +2 V, 50-ns pulse width ($\leq$ 10 MHz) will blank a trace of normal intensity.

1-9. Four rear-panel BNC connectors provide recorder outputs for use with spectrum analyzer plug-ins. Since these outputs are dependent upon the plug-ins utilized, the appropriate plug-in Operating and Service Manual should be referred to for identification of the output signals available.

NOTE

These outputs should not be used when a standard 1800-series plug-in is installed in the oscilloscope.

1-10. A calibrator provides a square-wave signal of approximately 1 kHz with a rise time of $< 3\ \mu s$. Amplitudes of 250 mV and 10 V are available.

1-11. The cathode ray tube has an internal graticule and P39 aluminized phosphor. The display area is eight by ten divisions. Each division equals 1 cm.

1-12. WARRANTY.

1-13. This instrument is certified and warranted as described inside the front cover of this manual. The CRT is covered by a separate warranty. The CRT warranty claim form are located at the rear of this manual. Should the CRT fail within the time specified on the warranty, process the warranty claim through your nearest HP Sales/Service Office.

CAUTION

The warranty may be void for instruments having a multilated serial tag.

1-14. ACCESSORIES FURNISHED.

1-15. The standard Model 180T/TR oscilloscope is supplied with a blue plastic light filter and a detachable power cord. Also included with the Model 180TR is a rack-mounting kit.

1-16. ACCESSORIES AVAILABLE.

1-17. A series of mobile test stands are available for the Models 180T and 180TR. The Model 1002B Testmobile is intended for use with the cabinet Model 180T. The Model 1117B Testmobile is intended for use with rack-model instruments such as the Model 180TR.

1-18. A front-panel protection cover, Model 10166A, is available for the cabinet Model 180T. A similar cover, HP Part No. 5060-0437, is available for the rack Model 180TR.

1-19. Cameras, probes, viewing hoods, terminations and other accessory items are available for specialized requirements. Information concerning accessories may be obtained from HP Sales/Service Offices listed in the rear of this manual.

1-20. INSTRUMENT AND MANUAL IDENTIFICATION.

1-21. This manual applies directly to Model 180T/TR instruments and serial prefix number as listed on the manual title page. The serial prefix number is the first group of digits in the instrument serial number (figure 1-1). The instrument serial-number tag is located on the rear panel.

1-22. Check the serial prefix number of the instrument. If the serial prefix number is different from that listed on the title page of this manual, refer to Section VII for instructions to adapt this manual for proper instrument coverage.

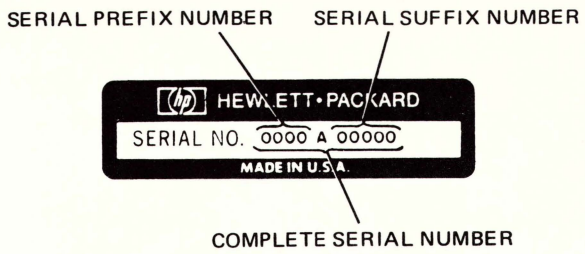


Figure 1-1. Instrument Serial Number

1-23. INQUIRIES.

1-24. Refer any questions regarding the manual, the Manual Changes sheet, or the instrument to the nearest HP Sales/Service Office. Always identify the instrument by model number, complete name, and complete serial number in all correspondence. Refer to the inside rear cover of this manual for a world-wide listing of HP Sales/Service Offices.

Table 1-1. Specifications

HORIZONTAL AMPLIFIER

EXTERNAL INPUT

Bandwidth: dc-coupled, dc to 5 MHz; ac-coupled, 5 Hz to 5 MHz.

Deflection Factor: 1 V/div, ±5% on X1; 0.2 V/div ±5% on X5; 0.1 V/div ±5% on X10. Vernier provides continuous adjustment between ranges.

Dynamic Range: ±20 V.

Input RC: 1 megohm shunted by approximately 30 pF.

Sweep Magnifier: X5, X10, accuracy ±5% with 3% accuracy time base.

CALIBRATOR

TYPE: approximately 1-kHz square wave, <3 μs rise time.

VOLTAGES: 10 V p-p into ≥1 megohm, accuracy ±1%. 250 mV p-p into ≥1 megohm, accuracy ±1%.

CATHODE-RAY TUBE AND CONTROLS

TYPE: post-accelerator storage tube, 15-kV accelerating potential, aluminized P39 phosphor.

GRATICULE: 8 x 10 div internal graticule, 1 div = 1 cm. Subdivisions of 0.2 div on major axes. Front-panel adjustment aligns trace with graticule. Scale control illuminates CRT phosphor when viewing with hood or taking photographs.

Z-AXIS BLANKING: approximately +2-V, ≥50-ns pulse width (≤10 MHz sine wave), will blank trace of normal intensity. Input resistance ≈5000 ohms.

BEAM FINDER: pressing FIND BEAM control brings trace on CRT screen regardless of setting of horizontal or vertical controls.

OUTPUTS

Four rear-panel BNC jacks provide recorder outputs for use with spectrum analyzer.

GENERAL

ENVIRONMENT

Temperature: 0° C to +55° C.

Humidity: to 95% relative humidity to 40°C.

Altitude: to 4.6 km (15 000 ft).

Vibration: vibrated in three planes for 15 min. each with 0.254 mm (0.010 inch) excursion, 10 to 55 Hz.

POWER: 115 Vac or 230 Vac ±10%, 48 - 440 Hz, <225 VA max with plug-ins, convection cooled.

WEIGHT: (without plug-ins) Model 180T: Net, 10.9 kg (24 lb), Shipping, 16.3 kg (36 lb). Model 180TR (rack): Net, 11.8 kg (26 lb); Shipping, 18.1 kg (40 lb).

ACCESSORIES FURNISHED: blue plastic light filter and detachable power cord. Rack mounting hardware and two clip-on probe holders for Model 180TR only.

Table 1-2. Reference Designators and Abbreviations

REFERENCE DESIGNATIONS

A	ASSEMBLY	E	MISC. ELECTRICAL PART	P	PLUG	U	INTEGRATED CIRCUIT (UNREPAIRABLE)
AT	ATTENUATOR RESISTIVE TERMINATION	F	FUSE	PS	POWER SUPPLY	V	VACUUM TUBE, NEON BULB, PHOTOCELL, ETC.
B	MOTOR, FAN	FL	FILTER	Q	TRANSISTOR	VR	VOLTAGE REGULATOR (DIODE)
BT	BATTERY	H	HARDWARE	R	RESISTOR	W	CABLE
C	CAPACITOR	J	JACK	RT	THERMISTOR	X	SOCKET
CP	COUPLING	K	RELAY	S	SWITCH	Y	CRYSTAL
CR	DIODE	L	INDUCTOR	T	TRANSFORMER	Z	NETWORK
DL	DELAY LINE	LS	SPEAKER	TB	TERMINAL BOARD		
DS	DEVICE SIGNALING (LAMP)	M	METER	TP	TEST POINT		
		MP	MECHANICAL PART				

ABBREVIATIONS

A	AMPERE(S)	F	FARAD(S)	n	NANO (10^{-9})	rfi	RADIO FREQUENCY INTERFERENCE
At	AMPERE TURN(S)	FET	FIELD-EFFECT TRANSISTOR(S)	nc	NORMALLY CLOSED	rms	ROOT MEAN SQUARE
ampl	AMPLIFIER(S)	G	GIGA (10^{9})	no.	NORMALLY OPEN	rwv	REVERSE WORKING VOLTAGE
assy	ASSEMBLY	gnd	GROUND(ED)	npn	NEGATIVE-POSITIVE-NEGATIVE	SCR	SILICON CONTROLLED RECTIFIER
ampltd	AMPLITUDE			ns	NANOSECOND	s	SECOND(S)
bd	BOARD(S)	H	HENRY(IES)	p	PICO (10^{-12})	std	STANDARD
bp	BANDPASS	h	HOUR(S)	pc	PRINTED (ETCHED) CIRCUIT(S)	trmr	TRIMMER
c	CENTI (10^{-2})	HP	HEWLETT-PACKARD	pk	PEAK	μ	MICRO (10^{-6})
ccw	COUNTERCLOCKWISE	Hz	HERTZ	pnp	POSITIVE-NEGATIVE-POSITIVE	μs	MICROSECOND
coax.	COAXIAL	if.	INTERMEDIATE FREQ.	p/o	PART OF	V	VOLTS
coef	COEFFICIENT	intl	INTERNAL	p-p	PEAK-TO-PEAK	var	VARIABLE
com	COMMON	k	KILO (10^{3})	prgm	PROGRAM	w/	WITH
CRT	CATHODE-RAY TUBE	kg	KILOGRAM	prv	PEAK INVERSE VOLTAGE(S)	w/o	WITHOUT
cw	CLOCKWISE	lpf	LOW-PASS FILTER(S)	ps	PICOSECOND	wiv	WORKING INVERSE VOLTAGE
d	DECI (10^{-1})	m	MILLI (10^{-3})	pwv	PEAK WORKING VOLTAGE		
dB	DECIBEL	M	MEGA (10^{6})	rf	RADIO FREQUENCY		
ext	EXTERNAL	ms	MILLISECOND				

SECTION II

INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains instruction for performing an initial inspection of the Model 180T/TR. Installation procedures and precautions are presented in step-by step order. The procedures for making claim for warranty repairs and for repacking the instrument for shipment are also described in this section.

WARNING

Read the Safety Summary at the front of this manual before installing or operating the instrument.

2-3. INITIAL INSPECTION.

2-4 The instrument was inspected mechanically and electrically before shipment. Upon receipt, inspect it for damage that may have occurred in transit. Check for broken knobs, bent or broken connectors, and dents or scratches. If damage is found, refer to the claims paragraph in this section. Retain the packing material for possible future use.

2-5. Check the electrical performance of the instrument immediately after receipt. Refer to Section V for the performance check procedure. The performance check will determine whether or not the instrument is operating within the specifications listed in table 1-1. Initial performance and accuracy of the instrument are certified as stated in the front of this manual. If the instrument does not operate as specified, refer to the claims paragraph in this section.

2-6. PREPARATION FOR USE.

2-7. POWER REQUIREMENTS. The power cord required depends on, (1) the ac input voltage, and (2) the country in which the instrument is to be used. Figure 2-1 illustrates the standard power receptacle (wall outlet) configurations that are used throughout the United States and in other countries. The HP part number shown directly above each receptacle drawing is the part number for a power cable equipped with the appropriate mating plug for that receptacle. If the appropriate power cable is not included with the instrument, notify the nearest HP Sales/Service Office and a replacement cable will be provided.

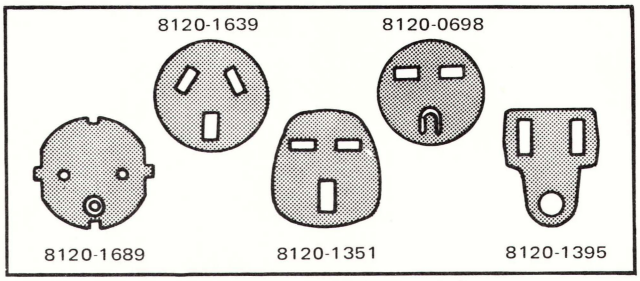


Figure 2-1. Power Receptacles

2-8. The instrument can operate on either 115 Vac or 230 Vac ±10%, single phase, 48 Hz to 440 Hz that can deliver approximately 200 volt-amperes. The instrument is normally shipped from the factory set to operate at 115 Vac. To operate from a 230 Vac source, proceed as follows:

a. Remove power cable (if connected).

b. Set switch on rear panel to 230 V position.

c. Replace fuse with 230 V, 1A fuse.

d. Install power cord.

2-9. THREE-CONDUCTOR AC POWER CABLE. For the protection of operating personnel, Hewlett-Packard Company recommends that the instrument panel and cabinet be grounded. This instrument is equipped with a three-conductor ac power cable that, when connected to an appropriate receptacle, grounds the instrument through the offset pin. The power jack and mating plug of the power cord meet International Electro-technical Commission (IEC) safety standards. To preserve this protection feature when operating from a two-contact outlet, use a three-conductor to two-conductor adapter, and connect the adapter wire to ground at the power outlet.

2-10. RACK MOUNTING. A kit for converting the Model 180TR to a rack mount is supplied with each instrument. Instructions for making the conversion are given below. Refer to figure 2-2 for parts identification.

a. Detach tilt stand by pressing it away from front feet. Remove all plastic feet by pressing metal button and sliding feet free.

b. Remove aluminum trim strip from each side of instrument with a thin blade tool.

c. Attach rack mounting flange in space from which trim strip was removed (use screws provided with kit). Large notch of flange should be positioned at bottom of instrument.

2-11. CLAIMS.

2-12. The warranty statement applicable to this instrument is printed at the front of this manual. The CRT warranty and claims form is located at the rear of this manual. If damage is found or if performance is not as specified, notify the carrier and the HP Sales/Service Office immediately. Refer to the back of this manual for addresses. The HP Sales/Service Office will arrange for repair or replacement without waiting for settlement of a claim with the carrier.

2-13. REPACKING FOR SHIPMENT.

2-14. If the instrument is to be shipped to an HP Sales/Service Office for service or repair, attach a tag showing owner (with address), instrument serial number, and a description of the service required.

2-15. Use the original shipping carton and packing material, if available. If not available, the HP Sales/Service Office will provide information and recommendations on material to be used. Materials for shipping an instrument normally include the following:

a. A double-walled carton. Refer to table 2-1.

b. Heavy paper or sheets of cardboard to protect all instrument surfaces; use a nonabrasive material such as Kimpak around all projecting parts.

Table 2-1. Shipping Carton Test Strength

Gross Weight (lb)	Carton Test Strength (lb)
up to 10	200
10 to 30	275
30 to 120	350
120 to 140	500
140 to 160	600

c. At least 4 inches of titghtly packed, industry-approved, shock-absorbing material such as extra-firm polurethane foam.

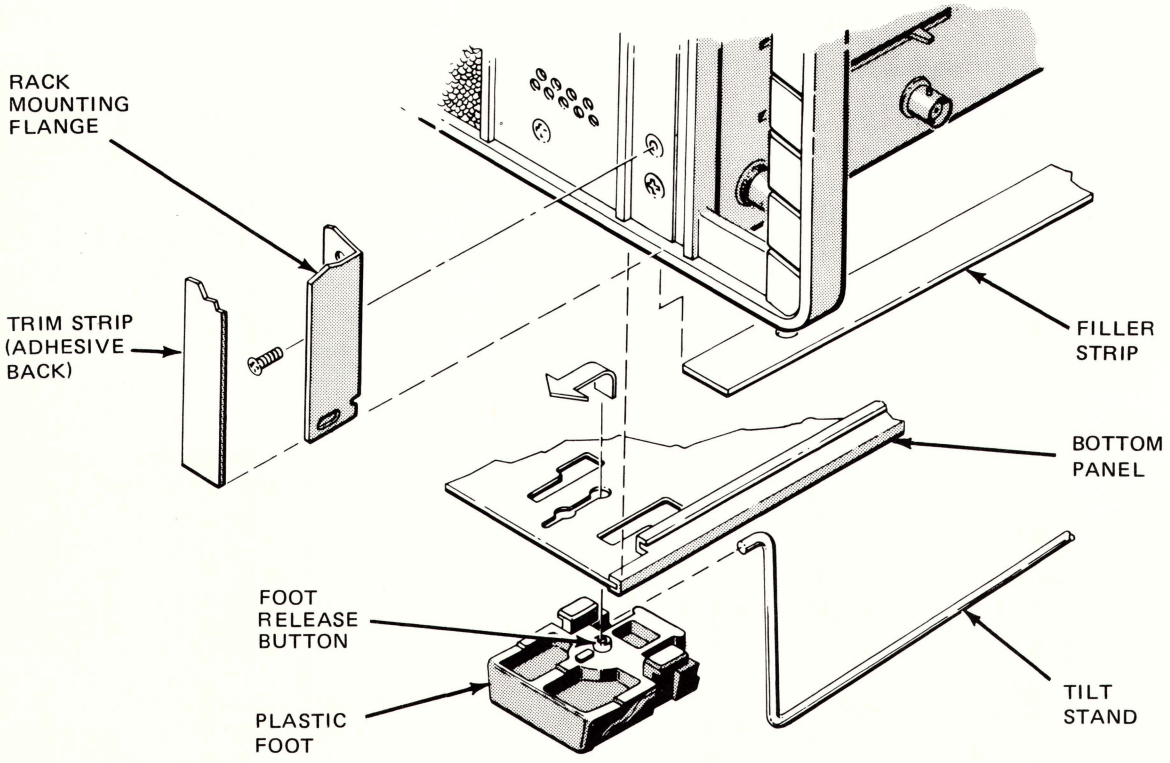


Figure 2-2. Bench/Rack-Mount Conversion

SECTION III

OPERATION

3-1. INTRODUCTION.

3-2. This section provides general information on the operation, function, and application of the instrument controls. Front- and rear-panel controls and connectors are identified and briefly described in figure 3-1.

3-3. The Model 180T and 180TR are designed to operate with real time, sampling and TDR, and frequency domain plug-ins. These plug-ins are accommodated in the lower portion of the instrument. The required operating power is obtained from the oscilloscope mainframe. Refer to the plug-in Operating and Service Manual for mating and installation instructions.

3-4. FRONT-PANEL CONTROLS AND CONNECTORS.

3-5. All operating controls and front-panel adjustments are identified and described in figure 3-1. The following paragraphs explain the function of some of the controls in detail.

3-6. CALIBRATOR. The calibrator has two outputs, 10 V and 250 mV peak-to-peak, negative-going from ground, with an amplitude accuracy of ±1%. The output is a square wave at a frequency of approximately 1 kHz. Rise time of the signal is less than 3 microseconds. These outputs are useful for checking vertical and horizontal sensitivity calibration, and divider probe calibration. A 3-way binding post provides a ground connection point and may be used with banana plug, wire, or spade lug connection.

3-7. SCALE. This control adjusts the overall brightness of the CRT graticule. It should be adjusted for good contrast between the background and the graticule. The SCALE control is useful when using a hood to view the display or when photographing waveforms. Rotate the SCALE control counterclockwise to OFF when graticule illumination is not needed.

3-8. TRACE ALIGN. This screwdriver adjustment compensates for external magnetic fields that may affect alignment of the horizontal trace with the graticule. Use it to position the trace parallel to the graticule horizontal lines. The alignment should be checked when the instrument is moved to a new location and adjustment made whenever necessary.

3-9. FOCUS AND ASTIGMATISM. These controls are used to obtain a display of uniform focus. Adjust both controls for the sharpest display possible.

3-10. FIND BEAM. Occasionally the CRT beam may be driven off-screen by large dc input levels or improper control settings. Pressing the pushbutton increases intensity and reduces horizontal and vertical amplifier gains enough to always return a displaced beam to the viewing area. This enables the operator to determine the action necessary to center the display. All operating controls function while the FIND BEAM control is pressed. For example, obtaining a centered display may require adjustment of the deflection factor, horizontal and vertical position, coupling, trigger level, or intensity. If the controls are properly set, the display will remain visible when FIND BEAM is released.

3-11. LINE. This toggle switch applies or removes ac line input power to the instrument. When ON, an indicator lamp, is illuminated. Power for the lamp is obtained from the low-voltage power supply. Both sides of the ac power line input are interrupted when switched to OFF.

3-12. COUPLING. The EXT COUPLING switch is used to select ac coupling (capacitive coupling) to the amplifier for alternating voltages or dc coupling.

3-13. HORIZONTAL MAGNIFIER. This switch controls the gain of the horizontal amplifier. When switched from X1 to X5 gain is increased five times, when switched to X10, the gain is increased ten times. For example, one volt into the horizontal amplifier EXT INPUT jack produces 1 division of defelction in X1 and 10 divisions of deflection in X10.

3-14. HORIZONTAL DISPLAY. Either of two modes of operation can be selected with this switch. It selects the origin of the input signal applied to the horizontal amplifier. When INT is selected, the input signal to the horizontal amplifier is obtained from the plug-in. With the switch in EXT, the sweep signal input from the plug-in is disconnected and input to the horizontal amplifier is obtained from the EXT INPUT connector located on the front panel.

3-15. EXT VERNIER. The deflection factor of an external input signal can be continuously varied to decrease deflection by a factor of approximately 10 by using this control. When the vernier is in the maximum clockwise position (CAL detent), the horizontal amplifier is calibrated to provide 1.0 V/div deflection in the X1 magnifier range, 0.25 V/div in X5 range, and 0.1 V/div in the X10 range.

3-16. REAR-PANEL CONTROLS AND CONNECTORS.

3-17. Rear-panel controls and connectors are identified and described in figure 3-1. Additional information regarding the function of the controls is explained below.

3-18. OUTPUTS. Four BNC connectors on the rear panel are provided to supply recorder signals from the spectrum analyzer.

3-19. Z-AXIS INPUT. An external signal can be utilized to control the CRT intensity. The intensity modulation signal is applied directly to the CRT intensity gate amplifier. A pulse of approximately +2 V amplitude and a width of at least 50 nanoseconds or a +2 V continuous wave (cw) input to 10 MHz or lower will blank a trace of normal intensity. Input of a negative signal can be used for display intensification.

3-20. AC LINE INPUT. A three-conductor ac power cord is provided for ac input. A power line ground is obtained through the power cord. Also located on the rear panel is the SELECTOR line slide switch, which allows operation from either 115 V or 230 V ac power line. Fuses are provided for both 115 V and 230 V operation, and must be charged to the proper value of the line input selected.

3-21. PHOTOGRAPHIC PROCEDURES.

NOTE

When using high-speed ASA 10,000 film, allow the CRT phosphor to decay for 2 minutes after the camera viewing port is closed and before the photograph is taken. This will allow phosphor excitation by ambient light to decay and prevent film overexposure with long shutter times.

3-22. CRT SPOT SIZE AND SPEED. Uniformity of spot size over the CRT display area will result in best resolution and detail. The oscilloscope focus and astigmatism controls should be adjusted to obtain the sharpest spot for the intensity setting required.

3-23. Trace focus can vary at different sweep speeds. Oscilloscope focus should be set at the sweep speed and intensity level which will be used to display the signal to be photographed. When photographing a single-shot signal, the focus can be set by using a test signal input having a repetition rate of less than 10 milliseconds. As the speed of the spot increases, more exposure time or a higher intensity display may be required for film recording of the signal.

3-24. EXPOSURE. Evaluation of the signal to be photographed may make it desirable to overexpose one portion of a signal to capture the part that is of greater interest. This occurs because the speed of the spot (ie: spot writing speed) affects the light output of the CRT. As an example: if the rise time of a fast pulse is the detail desired, display and photographic parameters could be set to capture this, while the flat-top portion might be overexposed and its detail uncertain. This occurs since the spot speed would be high for the rise time portion of the pulse and slower over the flat top portion.

3-25. CRT INTENSITY. The intensity level used to present a display for viewing or photography has a great effect on the oscilloscope writing rate and the proper photographic exposure. Small changes in intensity levels are usually compensated for by the overall range of film speed.

3-26. REPETITIVE SIGNAL.

a. Adjust Model 180T/TR, plug-in controls to obtain the desired signal display.

b. Adjust INTENSITY and FOCUS for sharpest trace.

c. Adjust SCALE for desired graticule contrast.

d. Expose film using shutter and aperture settings based on type of film employed and camera characteristics.

3-27. SINGLE SIGNAL.

a. Adjust Model 180T/TR plug-in controls to obtain the desired signal display using a test signal to establish vertical deflection, trigger control and sweep time settings.

b. Adjust INTENSITY and FOCUS for sharpest trace. Use a low repetition rate signal or single-shot signal in single-sweep operation while making these adjustments so that best approximation of the desired signal parameters is obtained.

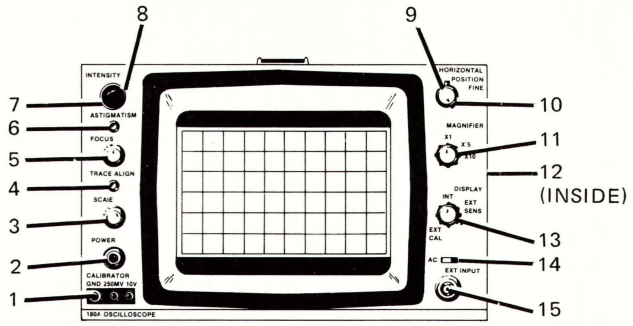
c. Set camera controls for desired operation, usually time or bulb.

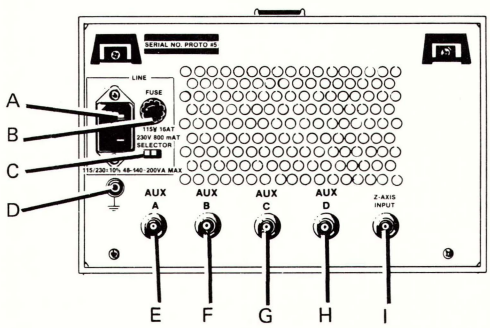
d. Open camera shutter and allow sweep to trigger on signal.

e. Adjust SCALE control for desired level of graticule illumination and post-fog film if necessary for extremely fast signals. A very low level of illumination, small lens opening and fast shutter speed will provide adequate post-fogging.

NOTE

Increased writing speed can also be obtained by a controlled exposure of Polaroid film to a light source before exposure to the displayed signal. This is called pre-fogging. Either post-fogging or pre-fogging techniques may be used. Results are approximately equivalent.





180T/TR-001

1. CALIBRATOR. Provides a 1-kHz square wave at two amplitudes; 250 mV and 10 V p-p.

2. LINE. Toggle switch with indicator light for turning oscilloscope on and off.

3. SCALE. Controls overall brightness of CRT face and graticule contrast.

4. TRACE ALIGN. Rotates trace around longitudinal axis of CRT.

5. FOCUS. Adjust writing beam for sharpest trace.

6. ASTIGMATISM. Adjusts roundness of writing spot.

7. INTENSITY. Controls brightness of display.

8. FIND BEAM. Intensifies trace and returns display to on-screen.

9. POSITION. Coarse adjustment of display's horizontal position.

10. FINE. Fine adjustment of display's horizontal position.

11. MAGNIFIER. Determines gain of horizontal amplifier.

12. Phase/Bandwidth. Selects between normal full bandwidth operation (Bandwidth) and X-Y operation (Phase).

13. DISPLAY. Selects source of horizontal input signal.

14. AC/DC. Selects ac or dc coupling for the external horizontal input signal.

15. EXT INPUT. BNC connector for coupling an external horizontal input signal to horizontal amplifier.

REAR PANEL

A. Power Connector. 3-wire ac power line input.

B. FUSE. 115 V or 230 V operation ac line fuse.

C. SELECTOR. Provides for external selection of line operating voltage.

D. Ground Connector. Provides a chassis ground connection point.

E. AUX A BNC connector for recorder output from spectrum analyzer.

F. AUX B BNC connector for recorder output from spectrum analyzer.

G. AUX C BNC connector for recorder output from spectrum analyzer.

H. AUX D BNC connector for recorder output from spectrum analyzer.

I. Z-AXIS INPUT. BNC connector for input of CRT intensification or blanking signal.

Figure 3-1. Operating Controls and Connectors

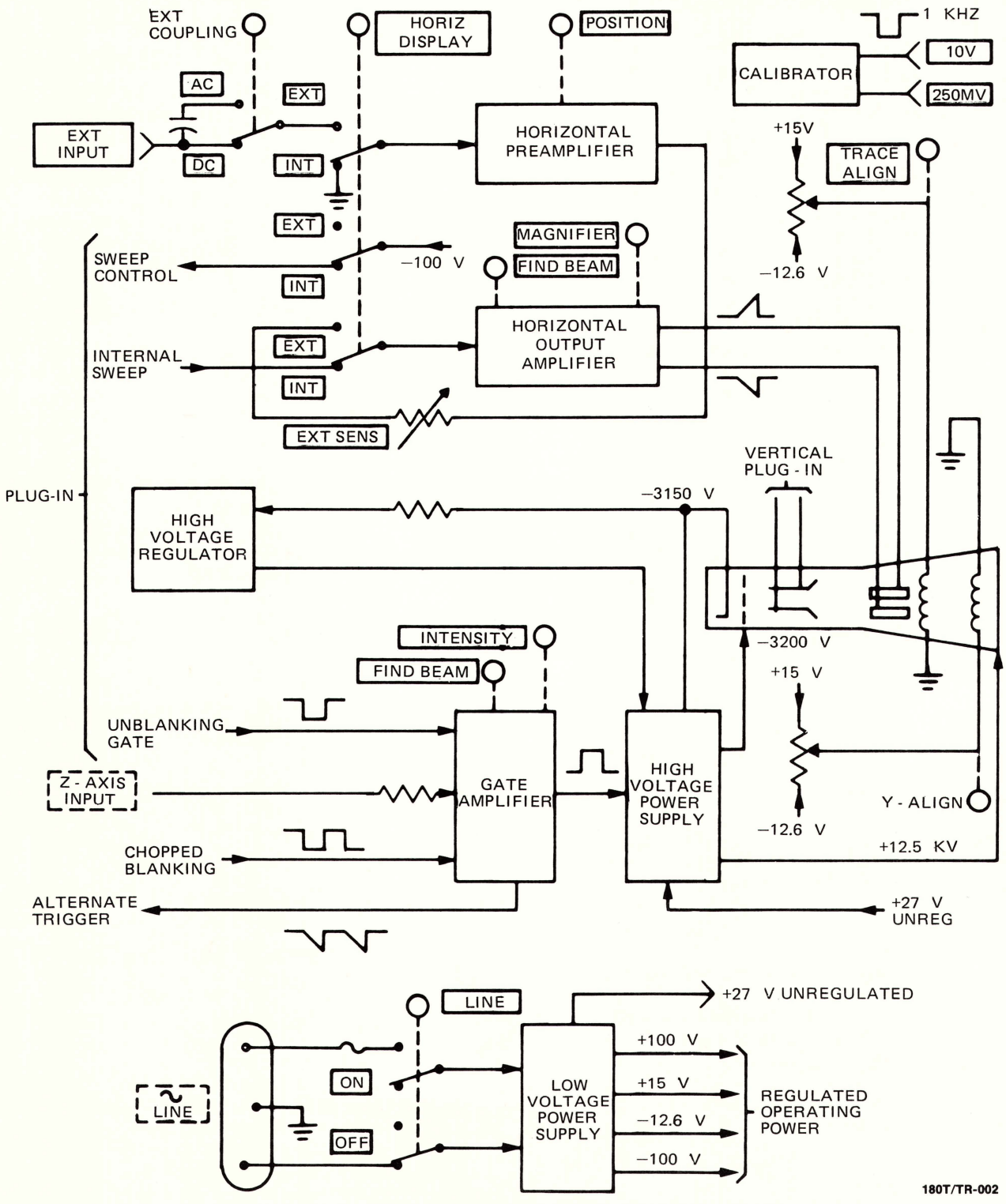


Figure 4-1. Overall Block Diagram

SECTION IV

PRINCIPLES OF OPERATION

4-1. INTRODUCTION.

4-2. This section provides circuit theory analysis of the Model 180T/TR oscilloscope. Refer to the overall block diagram (figure 4-1) and the schematics in Section VIII.

4-3. GENERAL DESCRIPTION.

4-4. The Model 180T/TR is an X-Y-axis display instrument designed for use with real time, sample and TDR, and spectrum analyzer plug-ins. The instrument contains the CRT and its controls, low-voltage and high-voltage regulated power supplies, a horizontal amplifier, and a gate amplifier.

4-5. To obtain a useful display on the CRT, three signals are necessary: vertical deflection, horizontal deflection, and intensity. The signal required for vertical deflection (Y-axis) of the CRT is supplied by the plug-ins. This signal is connected directly to the CRT vertical deflection plates. The horizontal (X-axis) deflection signal is also generated by the plug-ins. It is further amplified by the oscilloscope horizontal amplifier before being applied to the CRT horizontal deflection plates.

4-6. An unblanking gate signal, synchronized to the start of the horizontal sweep, is developed in the plug-ins and amplified by the gate amplifier. The signal from the CRT control grid, unblanking the viewing area of the CRT.

4-7. Signals for horizontal deflection and intensity modulation can also be applied to the oscilloscope from an external source other than the plug-ins. External input jacks are provided for this purpose.

4-8. INPUT POWER. With power applied to the power transformer primary windings, several secondary voltages are produced. They are rectified, filtered and regulated, as required, and used as the dc source of power for the various circuits of the oscilloscope and for operation of the plug-ins.

4-9. HORIZONTAL DEFLECTION. The horizontal amplifier may be used with either internal or external signal sources. Positioning the HORIZONTAL DISPLAY switch to INT arranges the circuitry to operate from signals supplied from the plug-in. In this condition, —100 V is applied to the plug-in. allowing it to operate and produce both a sweep signal and an unblanking gate signal.

4-10. The sweep signal from the plug-in is coupled to the oscilloscope horizontal output amplifier where it is converted to a differential signal, amplified, and applied to the CRT horizontal deflection plates.

4-11. Horizontal position of the X-axis sweep signal is controlled at the input stage of the horizontal output amplifier. A two section potentiometer, mechanically interconnected, is used to provide both fine and coarse positioning controls from a single knob.

4-12. Horizontal amplifier gain is controlled by the MAGNIFIER switch. Three settings can be selected: X1, X5 or X10. With X1 selected, the sweep speed corresponds to the selected plug-in sweep speed. In X10 operation the sweep speed is ten times that selected at the time base plug-in.

4-13. The unblanking gate signal from the plug-in is coupled to the gate amplifier where it is summed with the current from the INTENSITY control. The resulting signal is amplified and coupled through the high voltage supply to the CRT control grid to set the intensity of the displayed signals.

4-14. An externally applied signal for horizontal deflection may be connected to the EXT INPUT jack. The EXT VERNIER controls the externally applied signal and provides a variable gain adjustment for setting the X-axis display size. The EXT COUPLING switch provides for either direct (DC) or capacitive (AC) coupling of the external input signal. The external signal is coupled to a pre-amplifier, differentially amplified by the output amplifier, and applied to the CRT for horizontal deflection. Positioning and horizontal gain controls also function with external input signals.

4-15. CIRCUIT DETAILS.

4-16. INPUT AC POWER. Input line power is supplied by a detachable three conductor power cord. This cord has a standard plug for wall outlet connection providing an electrical ground. Both sides of the line power are filtered immediately at the power input connector.

4-17. The line power transformer has two primary windings. SELECTOR switch S5 connects these windings in parallel for 115 V operation and in series for 230 V operation. When set for use with a 115 V source of line power, a 2A fuse, F1, protects against excessive input current. When operated on 230 V line power, fuse F1 must be replaced with a 1A fuse which is also placed in the primary power circuit. With the front panel LINE toggle switch, S1, in the ON position, power is applied to the low-voltage power supply transformer and LINE lamp DS1 lights.

4-18. LOW-VOLTAGE POWER SUPPLY. The low-voltage power supply produces four regulated voltages for use throughout the oscilloscope and the plug-ins: +100 V, —100 V, +15 V and —12.6 V. Each supply is referenced to the +100 V supply for regulation purposes with the +100 V supply referenced to a 9-volt temperature-compensated zener diode A1A2VR2. The +100 V and —100 V supplies are also foldback current limited, providing short-circuit protection.

4-19. A simplified block diagram of a typical low-voltage power supply is shown in figure 4-2. Unregulated alternating power is supplied by the transformer, bridge rectified, and filtered. Changes in output voltage caused by input voltage variation or load changes are detected by the voltage sensor. Compared against a voltage reference, changes in output voltage are detected and applied as feedback to the driver, which controls the series regulator. The series regulator acts as a variable resistance and operates to increase its series resistance if the output voltage is high or decreases resistance when the output voltage is low. The action of the series regulator is to maintain output voltage at a constant level.

4-20. Current sensing takes place simultaneously with voltage sensing. If the load current increases above a certain level, the current sensor detects the increase as a voltage drop across the series resistor. This increased voltage drop causes the driver to bias the series regulator off.

4-21. The +100 V supply is used throughout the LVPS as a reference for the other supplies. It is both voltage and current regulated. Refer to the LVPS schematic while reading the following explanation.

4-22. One of the secondary outputs of A1T1 is coupled to a full-wave bridge rectifier consisting of A1A1 CR5-CR8. The rectified voltage is filtered by A1C1, and applied through fuse A2F1 to the regulator assembly. Fusing protects the rectifiers and transformer if a regulator malfunction results in excessive current flow. The regulator supplies sufficient current to the load to keep the output voltage at a constant +100 volts. Series regulator A1Q1 controls load current in order to maintain the output voltage at +100 V. Variations in output voltage due to changes in load or input line voltage are sensed by differential comparator A1A2Q3 and Q4. If the output of the +100 V supply changes, the full amount of the voltage change is applied to A1A2Q3 by A1A2VR2 while A1A2Q4 senses only a small part of the change in output voltage. The +100 V adjustment potentiometer A1A2R11 sets the operating point of A1A2Q4. The output of the differential comparator is coupled thru driver A1A2Q1, and used to control series regulator A1Q1.

4-23. A current limiting function is also part of the +100 V supply operation. All current furnished by the supply flows through A1A2R4. As the current requirements increase to the limit of the supply capability, the voltage drop across A1A2R4 causes A1A2Q2 to conduct. Since the collector of A1A2Q2 and the output of differential comparator A1A2Q3/Q4 are coupled to drive A1A2Q1, the amount of current flowing as well as voltage variations control the operation of series regulator A1Q1.

4-24. Resistors A1A2R2 and A1A2R3 are used in conjunction with A1A2R4 for current foldback operation. When current exceeds capability in a current foldback circuit, the output voltage will begin to drop and the load will receive less current. If the output of the supply is short-circuited, the output current will be limited to considerably less than the current available at full loading.

4-25. The +100 V supply is protected from turn-on and turn-off transients by diodes A1A2CR1 and A1A2CR2. Diode A1A2CR3 provides reverse voltage protection for A1A2C3.

4-26. A separate supply is used as a current source for A1A2Q3/Q4. This supply is used only in the LVPS regulator. The ac voltage from pins 11 and 12 of A1T1 is bridge rectified by A1A1CR1-CR4 and filtered by A1A1C1. The supply output is zener regulated by A1A2VR1 to approximately 5 volts more positive than the +100 V output.

4-27. The +15-volt supply provides three voltages. Approximately 30 Vac p-p is furnished for plug-in

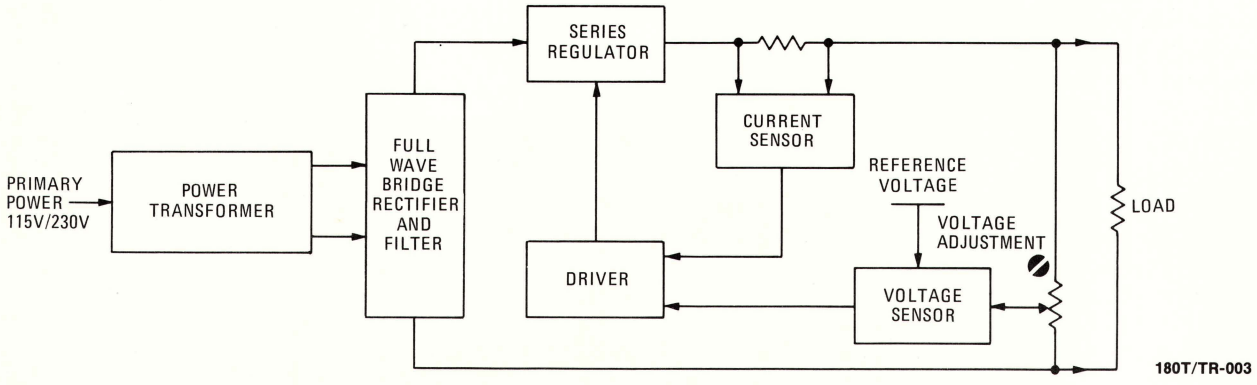


Figure 4-2. Simplified Low-voltage Power Supply

synchronization; an unregulated +27 V is furnished for operation of the HV oscillator; and a regulated +15 V is produced for use in the mainframe and plug-ins.

4-28. The secondary voltage developed by the power transformer at pins 13 and 14 is rectified by full-wave bridge A1A2CR9-A1A2CR12 and filtered by A1C2. Diode A1A1CR21 provides protection should another supply be shorted to +15 V. Series regualtor A1Q2 controls the amount of load current in order to maintain the output voltage at +15 V. Variations in output voltage are sensed by differential comparator A1A2Q7 and A1A2Q8. A reference voltage derived from the +100 V regulated supply is applied to A1A2Q7, while A1A2Q8 samples any change in output voltage due to load changes. The +15 V adjustment potentiometer A1A2R20 sets the operating point of A1A2Q8. The output of the differential amplifier is coupled to driver A1A2Q5 and used to control the series regulator.

4-29. Load current flows through A1A2R13. The voltage drop across this resistor is used to control the conduction of A1A2Q6, which has its collector coupled to driver A1A1Q5. Both current variations sensed by A1A2Q6 and voltage changes sensed by the differential amplifier are coupled to driver A1A1Q5 to control series regulator A1Q2. Protection from turn-on or turn-off transients is provided by A1A2CR4. Fuse A2F2 protects the +15 V rectifier and transformer in the event of a regulator short circuit.

4-30. The —12.6-volt supply operates in a manner similar to the +15 V supply. Changes in output voltage are sensed by differential comparator A1A2Q11 and A1A2Q12 and coupled to driver A1A2Q9 which controls the conduction of series regulator A1Q3. Current limiting action is provided by A1A2R22 and A1A2Q10. Fuse A2F3 protects against damage due to regulator failure and A1A2CR5 is used for voltage transient protection.

4-31. Operation of the —100 V supply is similar to the +100 V supply. A1A2Q15 and A1A2Q16 operate as a differential comparator, with A1A2Q16 sensing any change in output voltage. Transistor A1A2Q14 with A1A2R33 provides current limiting. Current foldback operation reduces the current output in the event of a short-circuited load. Voltage and current variations are coupled to driver A1A2Q13 which controls the conduction of series regulator A1Q4. Adjustment of the supply output voltage is accomplished with potentiometer A1A2R40. Turn-on/turn-off protection is furnished by A1A2CR6, while A1A2CR7 provides reverse voltage protection for A1A2C9.

4-32. GATE AMPLIFIER. The inputs to the gate amplifier are an unblanking gate, a chopped blanking signal, or an externally applied input Z-axis signal. These three signals may be present singly or simultaneously, depending on control settings and signals applied.

4-33. The unblanking gate is first applied as a current to A3Q11, a common base amplifier, then combined in the low impedance emitter circuit of A3Q1 with a current established by the INTENSITY, control. Pressing FIND BEAM shunts the adjustable INTENSITY potentiometer to increase emitter current and produce an intensified beam. Setting the horizontal DISPLAY to EXT supplies additional current from the —100 V supply. This establishes an unblanking current level to compensate for removal of the internal unblanking signal from the plug-in, and establishes a nominal brightness level.

4-34. The output voltage of A3Q1 is coupled through emitter follower A3Q2 to complimentary amplifier A3Q3/Q4. Diodes A3CR1 through A3CR4 provide a clamping action to prevent overdriving the amplifier.

4-35. A large negative feedback from the collectors of A3Q3 and A3Q4 ensure that the amplifier gain is very stable. Capacitors A3C3 and A3C5 provide for adjustment of the high frequency feedback and gain. Decreasing the capacitance of A3C3 decreases the high frequency feedback and increases gain, while decreasing the capacitance of A3C5 increases high frequency feedback and decreases gain.

4-36. The gate amplifier output unblanking signal is added to the —3200 V output of the high voltage power supply and applied to the CRT control grid. Voltage level changes of the unblanking signal cause corresponding changes to the CRT control grid voltage. Diodes A3CR6 through A3CR9 provide isolation protection against high voltage transients from the CRT control grid.

4-37. An alternate trigger signal is used by multichannel vertical amplifier plug-ins to initiate channel switching action. Transistors A3Q12 and A3Q13 function as a fast-acting switch. With A3Q12 normally conducting and A3Q13 non-conducting, the unblanking gate trailing edge causes A3Q13 to conduct and A3Q12 to cease conducting. The switching output is differentiated and applied to A3Q14, providing a negative-going voltage pulse for vertical amplifier channel switching.

4-38. The input impedance to the Z-axis input is approximately 5100 ohms. An input signal of approximately +2 volts amplitude is sufficient to blank a trace of normal viewing intensity, while an input signal of —2 volts will provide unblanking. Since the gate amplifier has a voltage gain of about 10, a 2-volt input will result in a 20-volt change at the CRT grid.

4-39. HIGH VOLTAGE POWER SUPPLY (HVPS). The HVPS generates three voltages. These are applied to the cathode (—3150 V), control grid (—3200 V) and post-accelerator (+15 kV) of the CRT to provide the accelerating potential required to produce excitation of the CRT phosphor for a visible trace. The HVPS is shown in simplified from in figure 4-3. Refer to this figure, and to the schematic in Section VIII while reading the following explanation of HVPS operation.

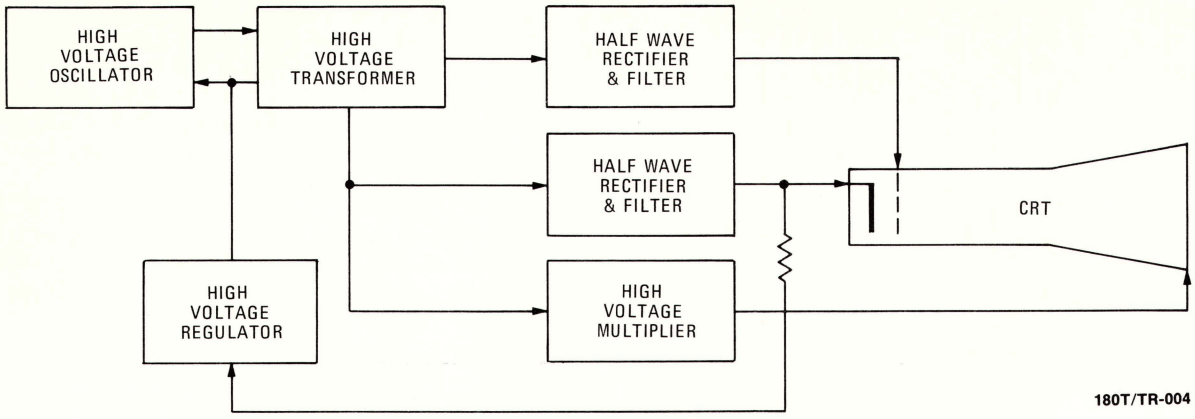


Figure 4-3. High-voltage Power Supply Block Diagram

4-40. Chassis-mounted transistor Q1 and transformer A5T1 form an oscillator that generates approximately 36 V p-p at 40 kHz. A feedback winding on the transformer provides the regenerative coupling to sustain oscillation. Operating power is provided by the unregulated +27 V supply. The supply source is fused and decoupled.

4-41. The 40-kHz oscillator output is stepped up by the secondary windings of A5T1. Two half-wave rectifiers and a voltage multiplier are used to develop the high voltages necessary for CRT operation.

4-42. The CRT grid voltage is developed by half-wave rectifier A5CR1 filter A5C1, A3R57, A3C23/C24/C25. Intensity limit A5R6 adjusts the CRT grid level to compensate for different CRT cut off levels. The CRT cathode voltage and the focusing voltage are developed by half-wave rectifier A5CR2 and filter A5C2. A3R8 and A3R59 along with FOCUS, R3, determines the focus voltage. The CRT post-accelerator voltage is developed by high-voltage multiplier assembly A6.

4-43. Variations in high voltage output are fed back to the high-voltage regulator circuitry consisting of A3Q8, A3Q9, A3Q10 and associated components. The regulator controls the high voltage oscillator bias to maintain high voltage at a constant level. If, for example, the CRT cathode voltage tends to decrease (go more positive), a positive-going signal is applied through the regulator to the base of oscillator Q1. The oscillator then conducts for a greater period of time, causing a larger voltage change at the primary of A5T1. This increases the secondary voltage to restore cathode voltage to the desired level.

4-44. The high-voltage regulator monitors CRT cathode voltage through coupling network A3R51 and A3C19. Resistors A3R49 and A3R48 form a voltage divider between +100 V and the coupling network output. A3R49 adjusts the operating level of A3Q8. High voltage fluctuations are sensed by A3Q8 and amplified by A3Q9 and A3Q10. The regulator output is applied through the regenerative winding of A5T1 as bias to the base of Q1, thereby controlling high-voltage oscillator drive.

4-45. CALIBRATOR. The calibrator provides outputs of 10 volts and 250 millivolts at approximately 1-kHz. The calibrator output is a negative-going waveform.

4-46. Transistors A3Q6 and A3Q7 oscillate at a rate determined by the time constant of associated RC components. A3CR11 disconnects the collector of A3Q7 from the negative discharge of A3C15 and A3Q7 cuts off, resulting in a faster rise time. Diodes A3CR12 and A3CR13 protect the transistors from voltage breakdown. A filter network, A3L2 and A3C16, isolates the multivibrator from the —100 V supply.

4-47. With A3Q7 conducting, voltage divider A3R34, A3R36, and A3R35 divides the —100 V supply voltage. The values selected for these resistors permit the output of 10 V and 250 mV. These two outputs are available at the front panel and may be used for probe compensation adjustment and horizontal or vertical sensitivity calibration checks.

4-48. HORIZONTAL AMPLIFIER. The inputs to the horizontal amplifier are an internal sweep signal from the plug-in or an external signal applied to the horizontal EXT INPUT jack. Positioning the horizontal DISPLAY to INT grounds the input of the preamplifier and disconnects the external signal preamplifier from the output amplifier. The internal sweep signal is connected through the horizontal DISPLAY switch to the output amplifier.

4-49. Positioning horizontal DISPLAY to EXT disconnects the internal sweep signal and connects the external signal through the preamplifier to the output amplifier. With EXT selected, the amplitude of the signal from the preamplifier is adjustable by rotating the EXT VERNIER control. When the control is in the CAL detent position the output amplitude of the preamplifier is determined by circuit design and the input amplitude.

4-50. The selected signal is applied to the output amplifier and summed with a current established by the horizontal POSITION control. A horizontal MAGNIFIER allows the gain to be increased by a

factor of 10 (X10); 5 (X5) or to be directly related to the amplitude of the input signal (X1). The resulting current is converted to a differential signal, amplified, and applied to the horizontal deflection plates of the CRT.

4-51. An external signal applied to the preamplifier is coupled through a divider composed of A2R4 and A2R6 to A2Q1. The output of A2Q2 is coupled through the horizontal EXT VERNER and the horizontal DISPLAY switch. The high input impedance of A2Q1, in conjunction with the voltage divider and A2R5, provides a 1 megohm load to the external circuit. Transistor A2Q2 is an emitter follower that supplies a current, determined by A2R12 and the EXT VERNIER control, to A2Q3.

4-52. A vernier balance adjustment A2R14 is used to establish a zero input voltage reference level. This eliminates horizontal dc shift as the EXT VERNIER control is rotated. The EXT VERNIER provides a range of control of the deflection factor when an EXT INPUT signal is used for horizontal deflection. It has sufficient range to change the deflection factor by at least 10.

4-53. The input signal to A2Q3 is summed in the low impedance emitter circuit with a current established by the horizontal POSITION and FIND controls. The output of A3Q3 has both a static dc level, as determined by the POSITION and FIND controls, and an active level as determined by the input signal.

4-54. The output of A2Q3 is coupled through emitter-follower A2Q4 to differential amplifier A2Q5 and A2Q10. The low impedance necessary to drive A2Q5 is provided by A2Q4, and A2Q9 maintains a similar low impedance voltage source for A2Q7.

4-55. The position of the MAGNIFIER switch A2S3 selects either of two values of emitter degeneration between A2Q5 and A2Q10 and controls the gain. As degeneration decreases, gain increases. Three gain levels are provided X1, X5 and X10. Each has an adjustable element to provide for calibration of the gain. With X1 magnification selected, A2R35 is used to set the gain. With X10 magnification selected A2R31 sets the gain. The emitter potentials of A2Q5 and A2Q10 are balanced by A2R38. This prevents horizontal dc shift as the MAGNIFIER control is switched between ranges.

4-56. The differential signal at the collectors of A2Q5 and A2Q10 is applied to current-fed operational amplifiers A2Q6/A2Q7/A2Q8 and A2Q11/A2Q12/A2Q13. The amplifier low frequency gain is very stable because of the large negative feedback employed, and the high frequency feedback for each side of the amplifier is separately adjustable. High frequency feedback from the collectors of A2Q7/A2Q8 to the base of A2Q6 is controlled by A2C12; high frequency feedback from the collectors of A2Q12/A2Q13 to the base of A2Q11 is controlled by A2C20. Capacitor A2C12 adjusts the ratio of feedback for each side of the amplifier. The output of the amplifiers is a voltage that is connected to the horizontal deflection plates of the CRT.

4-57. Diodes A2CR3/A2CR4 and A2CR7/A2CR8 limit the output to the deflection plates to prevent overdriving. Diodes A2CR2 and A2CR6 prevent A2Q5 and A2Q10 from saturating.

4-58. Pressing the FIND BEAM control disables diode limiter A2CR7/A2CR8 and blocks the signal to A2Q11. The differential gain is effectively cut in half, and the horizontal deflection of the beam is confined to the limits of the CRT.

4-59. POWER SUPPLY DECOUPLING. Decoupling networks are used on each etched circuit assembly for the supply voltages. The use of decoupling is important to prevent extraneous signals or noise from being introduced into circuitry from the power supplies or supply leads. Decoupling also prevents transients originating in other circuits from being introduced.

SECTION V

PERFORMANCE CHECK AND ADJUSTMENTS

5-1. INTRODUCTION.

5-2. This section contains step-by-step procedures for checking instrument performance and for making all internal adjustments. Performance checks should be made in numerical sequence for best results. Also included are test setup illustrations and a list of recommended test equipment.

5-3. The Models 180T/TR is intended for use with a number of different plug-ins. These plug-ins are classified as real time, sampling and TDR, and frequency domain. Certain features of the mainframe apply only to real time plug-ins. The performance checks and adjustment procedures note when these differences occur and indicate which group of plug-ins listed below are covered by the procedures.

Group A Real Time Plug-ins	Group B Sampling and TDR, Frequency Domain Plug-ins
Model Numbers	Model Numbers
1801A, 1803A, 1804A, 1805A, 1806A, 1807A, 1808A, 1809A, 1820C, 1821A, 1824A, 1825A	1810A, 1811A, 1815A, 1818A, 8558B, 8755A, 8557A

5-4. EQUIPMENT REQUIRED.

5-5. A complete list of required test equipment and accessories is given in table 5-1. Test equipment equivalent to that recommended may be substituted, provided it meets the required characteristics listed in table 5-1. For best results, use recently calibrated test equipment.

5-6. PERFORMANCE CHECKS.

5-7. The performance checks given in this section are suitable for incoming inspections, preventative maintenance, and troubleshooting. The checks are designed to verify the published instrument specifications. Perform the checks in the order given, and record the measured information on the performance check record at the end of this section.

5-8. ADJUSTMENTS.

5-9. The adjustment procedures are arranged in a recommended sequence. While most adjustments may be made independently, it is recommended that adjustments be made sequentially as a number of adjustments are directly related to preceding or following adjustments.

5-10. PERFORMANCE CHECK RECORD.

5-11. Each measurement point in the performance check is repeated in the performance check record. The pages may be removed for filing. The first time the performance check is made, enter the results on the performance check record and file it for future reference.

5-12. PRELIMINARY SETUP.

5-13. Set the line voltage SELECTOR switch, located on rear panel, to desired power line operating voltage (115 V ac or 230 V ac). Connect instrument to line power source and apply power by turning LINE power switch ON. Allow fifteen minutes for warm-up. Do not install plug-ins.

5-14. PERFORMANCE CHECK PROCEDURES.

5-15. CALIBRATOR. The calibrator function is typically used with group A plug-ins only. This check can be eliminated when using group B plug-ins.

Specification: the calibrator outputs are 10 V, and 250 mV 1-kHz square wave, with a rise time of less than 3 μs. The calibrator is checked by comparison with a known amplitude signal.

5-16. Perform calibrator check as follows:

a. Set controls as follows:

MAGNIFIER X10
DISPLAY ..... EXT
EXT COUPLING ..... AC

b. Connect 10 V p-p signal from voltmeter calibrator to EXT INPUT (see figure 5-6).

c. Obtain horizontal trace by adjusting INTENSITY, FOCUS, and POSITION controls.

d. Adjust EXT VERNIER to obtain trace of exactly 10 divisions.

e. Disconnect voltmeter calibrator from EXT INPUT. Do not disturb EXT VERNIER setting.

Table 5-1. Recommended Test Equipment

Instrument		Required Characteristics	Required For
Type	Model		
Voltmeter Calibrator	HP Model 728A	1 V, 2 V, 10 V p-p ±0.2%	Calibrator Check Magnifier Check
Test Oscilloscope	HP Model 180C/D w/1801A & 1820C	Sensitivity: 1 V/div Sweep Speed: 1 μs Rise time: 3 μs Sweep Output	Calibrator Check Gate Ampl Response
Test Oscillator	HP Model 652A	50 kHz - 5 MHz at 10 V p-p	Bandwidth Check Trace Alignment Adj Pulse Circuit Adj
Digital Voltmeter	HP Model 3440A w/3444A	±100 Vdc ±0.5% 2.5 mA ±2%	LVPS Adj HVPS Adj
Divider Probe	HP Model K05-3440A	Ratio 1000:1 3000 Vdc, ±0.1%	HVPS Adj
Square-wave Generator	HP Model 211A/B	200-kHz, 1 V p-p Rise Time: 30 μs	Horiz Transient Response
Time-mark Generator	HP Model 226A	1-ms markers	Horiz Amplifier Gain Adj Linearity
Divider Probe	HP Model 10002B	Ratio 50:1 ±3%	Gate Ampl Response
BNC Tee	HP Part No.1250-0781	BNC 50-ohm	Phase Adj
BNC Cable	HP Part No. 10502A	9 inch	Transient Response
BNC Cable	HP Part No. 10501A	44 inch	Phase Adj Transient Response

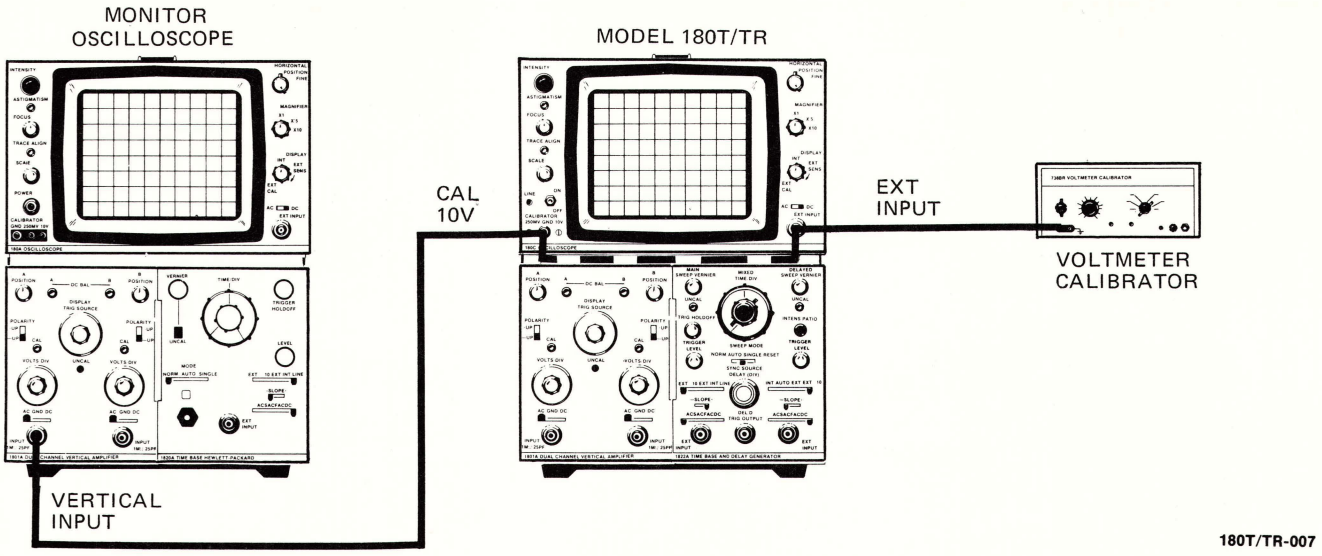


Figure 5-1. Calibrator Test Setup

f. Connect CALIBRATOR 10 V output to EXT INPUT.

g. Note trace of 10 ±0.1 divisions.

h. Disconnect CALIBRATOR 10 V output from EXT INPUT.

i. Observe CALIBRATOR 10 V output using monitor oscilloscope.

j. Rise time of calibrator waveform (leading edge) should be 3 μs or less. Rise time is measured at 10% to 90% amplitude points.

NOTE

The 250 mV should be correct after checking the 10 V output, however the 250 mV can be checked by comparison with a known source.

5-17. MAGNIFIER. This check is applicable to both group A or group B plug-ins, however calibration is relatively unimportant when using group B plug-ins.

Specification: sweep magnifier increases gain by factors of X1, X5 and X10. The magnifier is checked by applying a known signal and verifying that the multiple of the switch setting is displayed on the CRT screen.

5-18. Perform magnifier check as follows:

a. Set controls as follows:

MAGNIFIER	X1
DISPLAY	EXT
EXT VERNIER	CAL

b. Connect 10 V p-p signal from voltmeter calibrator output to EXT INPUT (see figure 5-2).

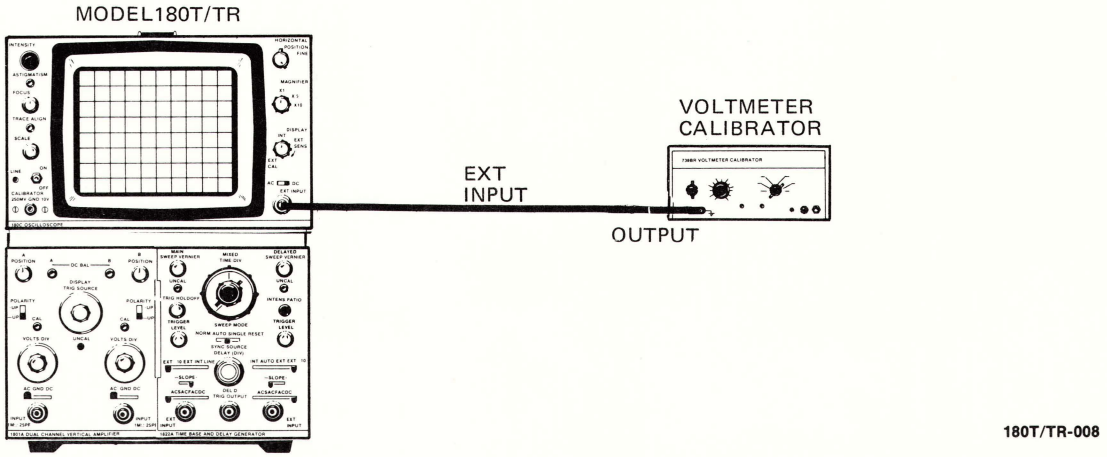


Figure 5-2. Magnifier Test Setup

c. Note trace of 10 ±0.5 divisions.

d. Set voltmeter calibrator for output of 2 V p-p.

e. Set MAGNIFIER to X5.

f. Note trace of 10 ±0.5 divisions.

g. Set voltmeter calibrator to 1 V p-p.

h. Set MAGNIFIER to X10.

i. Note trace of 10 ±0.5 divisions.

5-19. BANDWIDTH. This check is applicable only when using group A plug-ins in high frequency X-Y applications. Bandwidth is relatively unimportant when using group B plug-ins.

Specification: dc coupled, dc to 5 MHz; ac coupled, 5 Hz to 5 MHz. To check bandwidth, a test oscillator is used to apply 50-kHz, 10-div display. The frequency is then increased to 5 MHz. The signal amplitude should be 7.1 div or greater.

5-20. Perform bandwidth check as follows:

a. Apply a 50-kHz signal from test oscillator to HORIZONTAL EXT INPUT connector (see figure 5-3).

b. Set MAGNIFIER control to X1 and adjust INTENSITY for visible display.

c. Adjust test oscillator amplitude and Model 180T/TR POSITION controls for a 10-div display.

d. Note indication on test oscillator output meter.

e. Increase test oscillator output frequency to 5 MHz.

f. Increase test oscillator output to that noted in step d.

g. Display deflection should be ≥7.1 div.

h. If deflection is less than 7.1 div verify Phase/Bandwidth switch, A5S1, is in Bandwidth position.

5-21. FIND BEAM. This check is applicable when using either group A or group B plug-ins.

Specification: display returns to viewing area of CRT when FIND BEAM is pressed. To check FIND BEAM the display is positioned off screen and when FIND BEAM pushbutton is pressed display returns to screen.

5-22. Perform FIND BEAM check as follows:

a. Set controls as follows:

INTENSITY	fully ccw
POSITION	fully ccw

b. Press FIND BEAM pushbutton.

c. Note that intensified beam is displayed.

5-23. This completes the Performance Check. If the instrument does not meet specifications listed in table 1-1, the Adjustment Procedure that follows should be accomplished. If this does not result in satisfactory instrument performance refer to Section VIII of this manual for troubleshooting and maintenance information.

5-24. ADJUSTMENT PROCEDURE.

WARNING

Read the Safety Summary at the front of this manual before performing adjustment procedures.

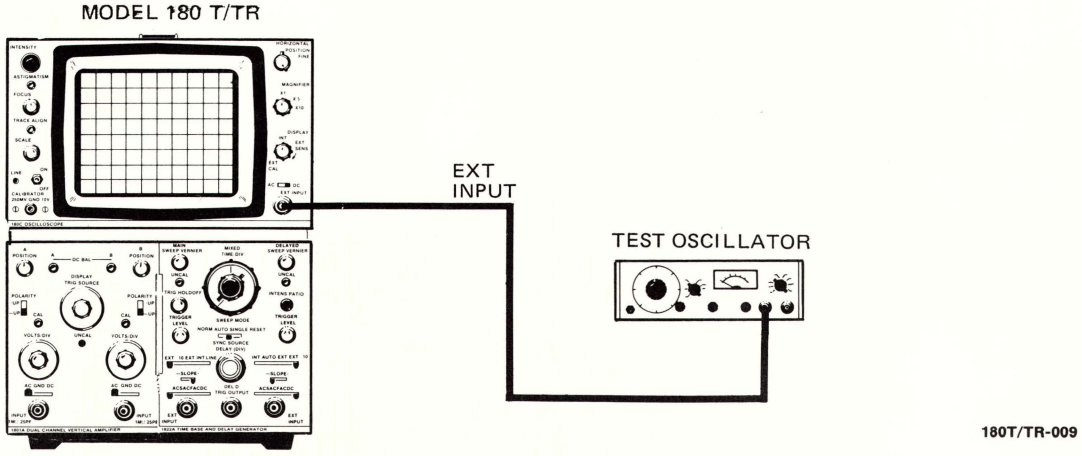


Figure 5-3. Bandwidth Test Setup

5-25. The following paragraphs describe the procedure to calibrate the instrument so that it will perform as specified in table 1-1. Use the equipment recommended in table 5-1 or similar equipment having at least equivalent characteristics. Use a non-metallic adjustment tool only. Adjustment locations are identified in figure 5-23.

5-26. The adjustment procedures should be performed in the sequence listed since some adjustments are dependent on control settings and results of previous steps. The adjustments may be accomplished individually, if desired, by referring to the preliminary control settings and the steps before the desired procedure.

5-27. COVER REMOVAL. To gain access to the adjustments, top and bottom covers and the rear LVPS access panel must be removed as shown in figure 5-4. Remove the covers as follows:

a. Ensure that LINE power switch is OFF; disconnect power plug from ac power source.

b. Release quarter-turn fasteners on each side of instrument.

c. Loosen captive screws located on handle ends (Model 180T).

d. Remove top cover by expanding open end slightly and pulling away from instrument.

e. Remove bottom cover by extending tilt stand, expanding open end of cover, and pulling away from instrument.

f. Remove rear access cover by releasing single quarter-turn fastener.

5-28. PRELIMINARY ADJUSTMENT SETUP. Install plug-ins in Model 180T/TR. Set line voltage SELECTOR switch, located on rear panel, to desired power line operating voltage 115 V ac or 230 V ac. Connect instrument to line power source and apply power by turning LINE power switch ON. Allow fifteen minutes for warm-up.

5-29. LOW VOLTAGE POWER SUPPLY (LVPS). This adjustment is applicable when using either group A or group B plug-ins. Perform LVPS adjustment as follows:

a. Using digital voltmeter measure voltages at test points listed in table 5-2. Adjustment locations are shown in figure 5-5.

NOTE

Tolerances listed in table 5-2 are not critical to actual instrument operation, but should be adhered to if plug-in interchangeability among mainframes is desired.

Table 5-2. Low Voltage Adjustments

Test Points	Measure	Adjust
A1A2TP4	−100 V ±0.1 V	A1A2R40
A1A2TP1	+100 V ±0.1 V	A1A2R11
A1A2TP3	−12.6 V ±0.1 V	A1A2R29
A1A2TP2	+15 V ±0.1 V	A1A2R20

5-30. HIGH VOLTAGE POWER SUPPLY (HVPS). This adjustment is applicable when using either group A or group B plug-ins. Tight voltage tolerance is only necessary to single sweep applications of group A plug-ins. Perform HVPS adjustment as follows:

a. Monitor −100 V at A1A2TP4 with dc voltmeter using a 1000:1 divider probe (see figure 5-6).

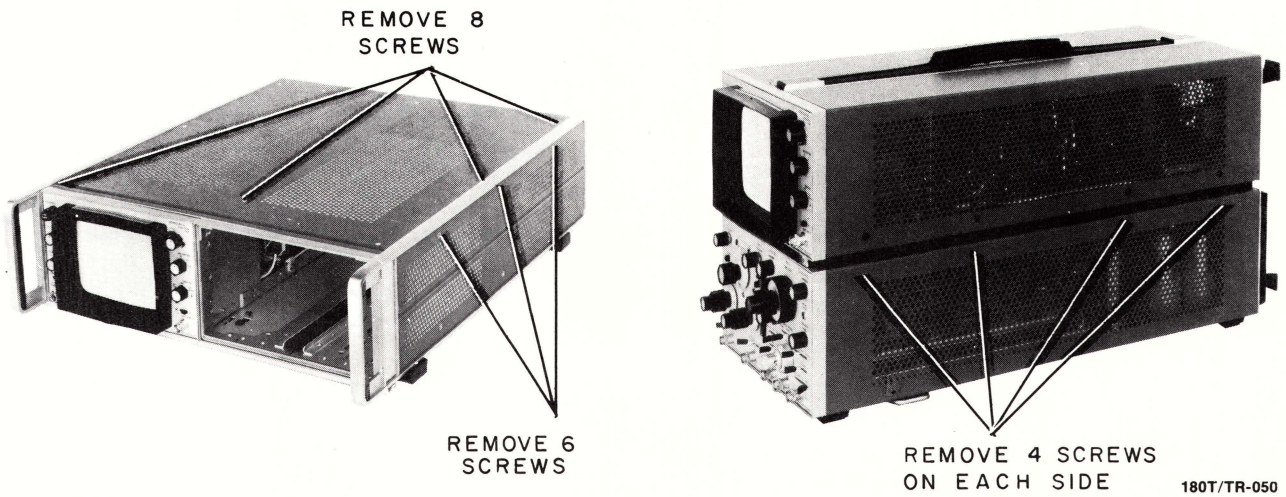


Figure 5-4. Cover Removal

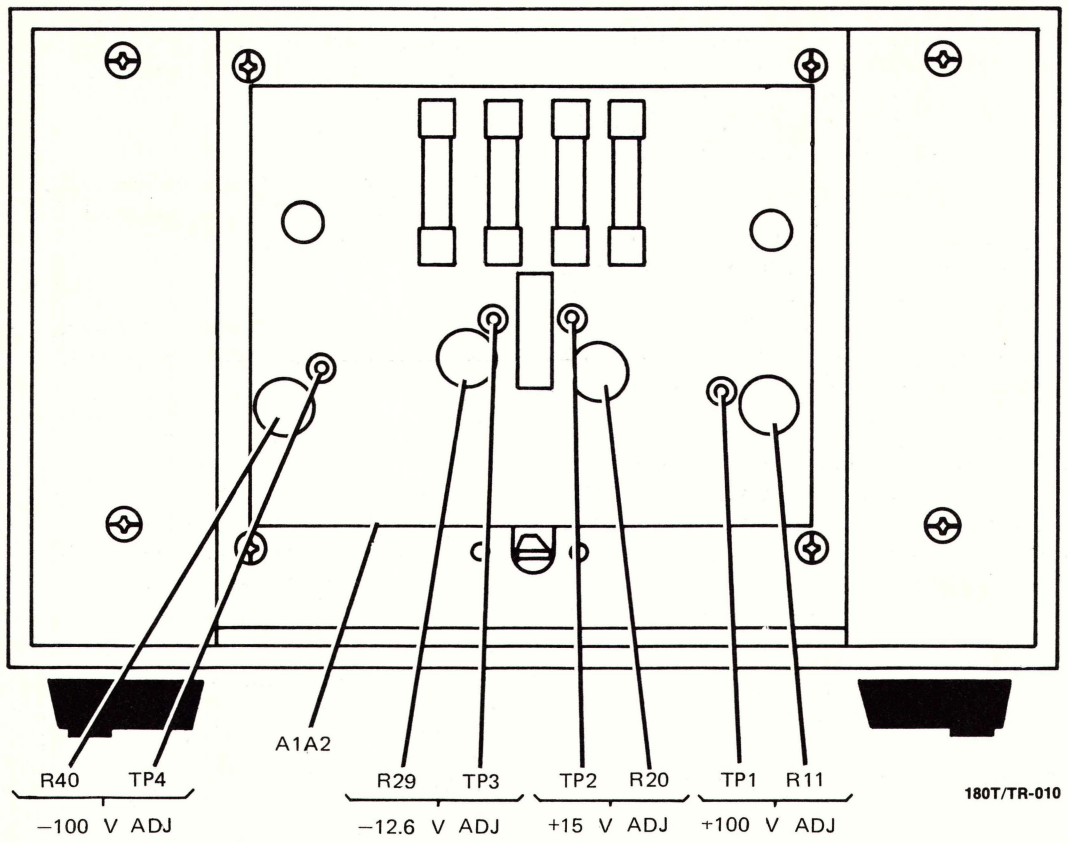


Figure 5-5. Low Voltage Power Supply Adjustments

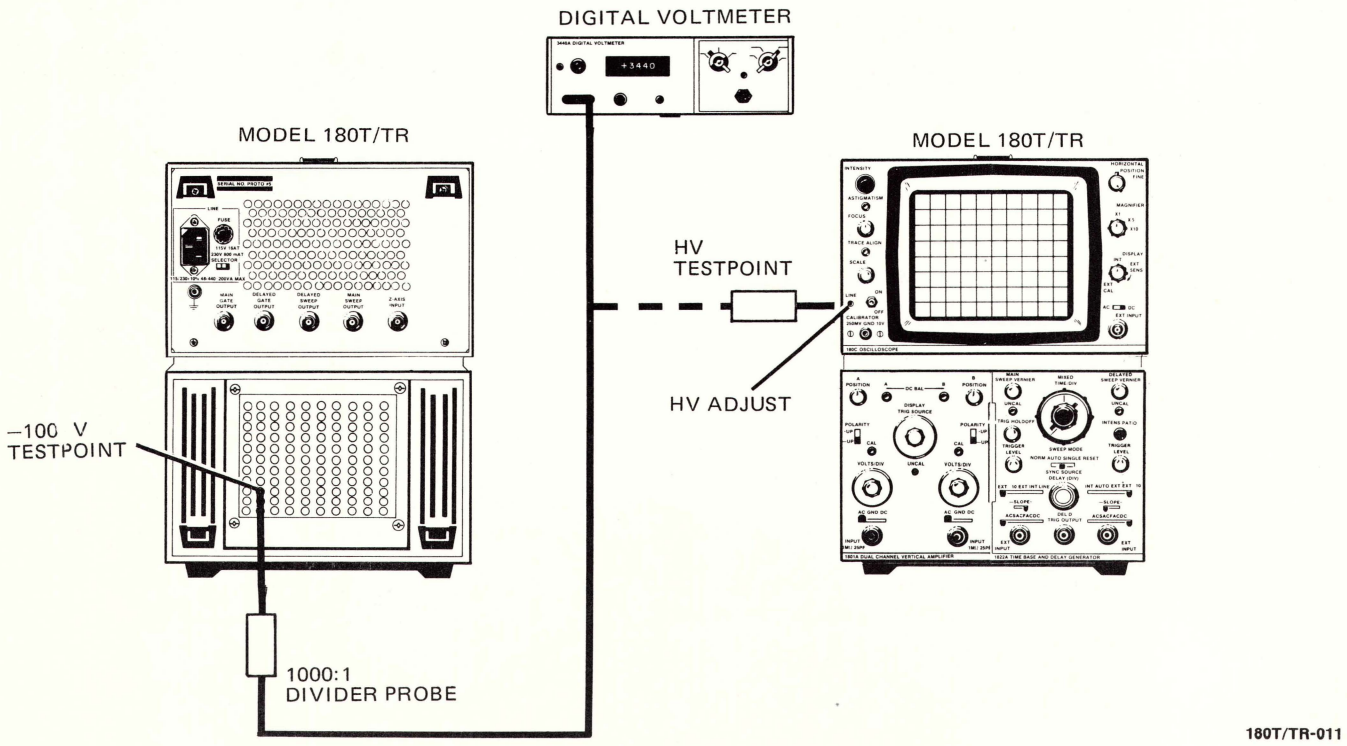


Figure 5-6. High Voltage Adjustment Test Setup

WARNING

Contact with high-voltage power supply voltage can result in injury or death.

b. Observe voltage reading and note result.

c. Multiply 31.50 by result obtained in step b.

d. Monitor voltage at A3TP1 with dc voltmeter using 1000:1 divider probe (see figure 5-7).

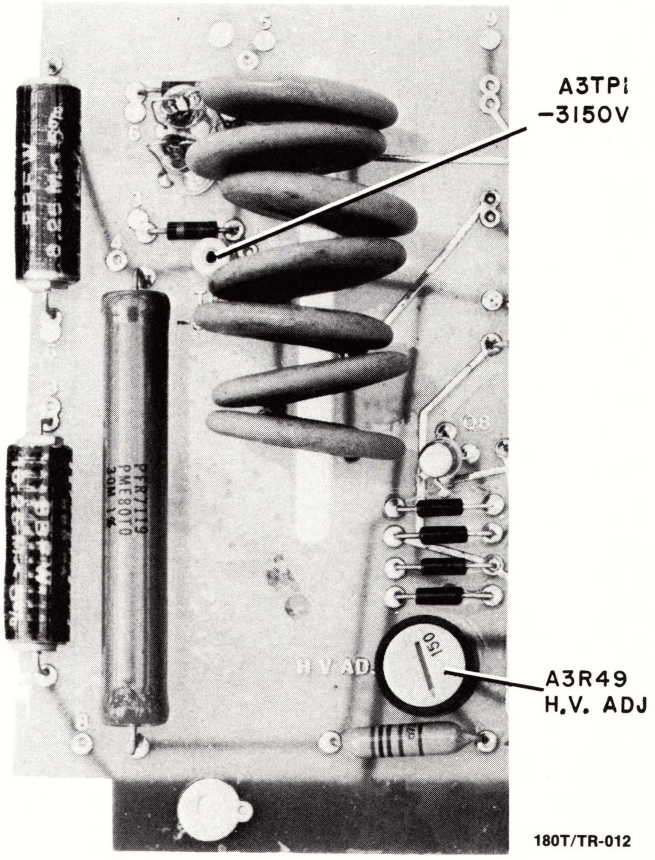


Figure 5-7. High Voltage Adjustment Location

e. Adjust HV Adj, A3R49, to obtain same voltage reading as calculated in step c.

5-31. ASTIGMATISM. This adjustment is applicable when using either group A or group B plug-ins. When using group B plug-ins adjust vertical controls so spot contains no appreciable noise. Perform astigmatism adjustment as follows:

a. Set DISPLAY to EXT.

b. Center low intensity spot with HORIZONTAL and VERTICAL POSITION controls.

c. Adjust FOCUS and ASTIGMATISM front-panel screwdriver adjustment for smallest round spot (see figure 5-8).

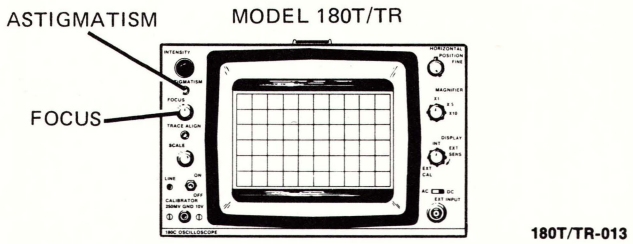


Figure 5-8. Astigmatism Adjustment

5-32. INTENSITY LIMIT. This adjustment is applicable when using either group A or group B plug-ins. The intensity limit normally needs adjustment at time of CRT replacement only. Adjustment is only important to single sweep application with group A plug-ins. Perform intensity limit adjustment as follows:

a. Set DISPLAY to EXT.

b. Set INTENSITY control to center (12 o'clock) position.

c. Adjust Intensity Limit Adj, A5R2, to just extinguish spot.

5-33. FLOOD GUN. This adjustment is applicable when using either group A or group B plug-ins. Perform flood gun adjustment as follows:

a. Set INTENSITY fully ccw.

b. Set SCALE fully ccw.

c. Adjust Flood Pattern Adj, A3R60, for uniform illumination intensity when SCALE control is varied throughout its full range (see figure 5-9).

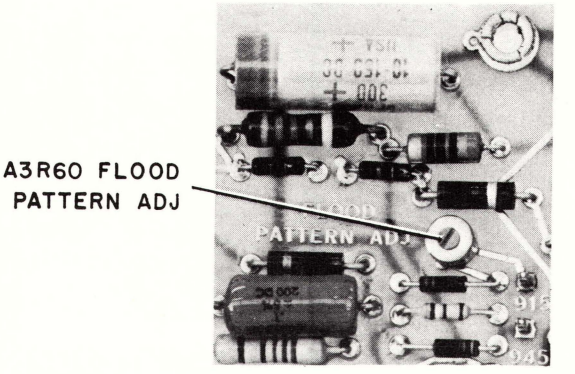


Figure 5-9. Flood Gun Adjustment Location

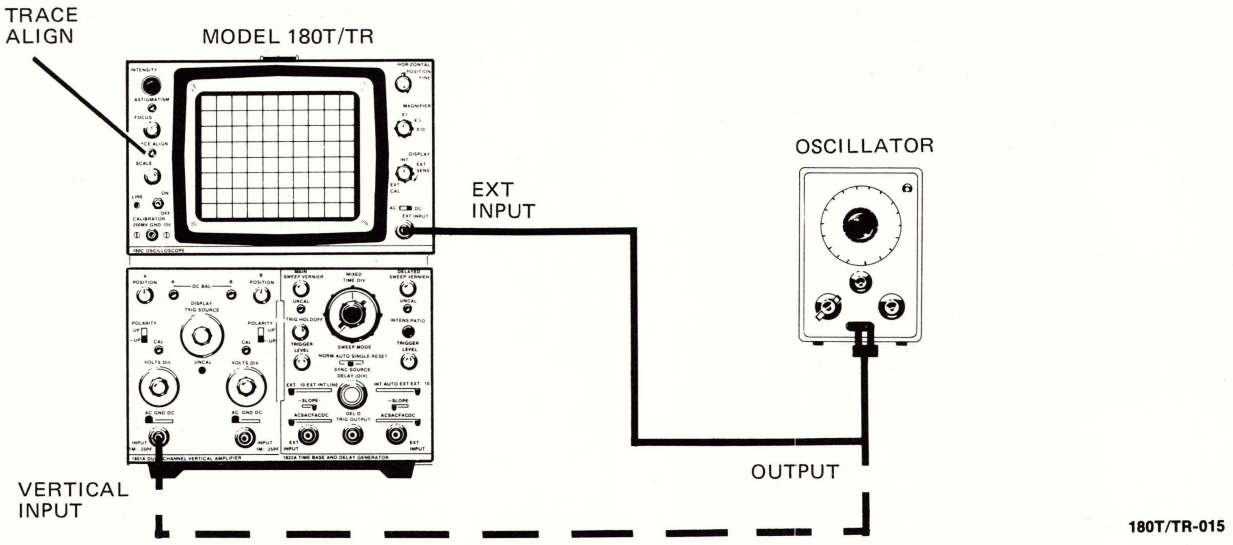


Figure 5-10. Trace Alignment Adjustment Test Setup

5-34. TRACE ALIGNMENT. This adjustment is applicable when using either group A or group B plug-ins. When using group B plug-ins, the front panel TRACE ALIGN can be set using any free-running trace or an input into the external horizontal input. Y align can be set with any vertical information inserted with horizontal in EXT and no external input applied. Perform trace alignment as follows:

a. Set MAGNIFIER to X1.

b. Set EXT COUPLING to AC.

c. Connect test oscillator 400-Hz, 10 V output to EXT INPUT (see figure 5-10).

d. Position trace on center horizontal graticule line.

e. Set INTENSITY and FOCUS to view sharply defined trace.

f. Adjust TRACE ALIGN front-panel screwdriver adjustment, R6, to align trace parallel to horizontal graticule line.

g. Connect test oscillator 400-Hz, 10 V output to vertical plug-in.

h. Set plug-in controls to obtain vertical trace.

i. Adjust Y ALIGN Adj, A2R57, to align vertical trace parallel to vertical graticule line (see figure 5-11).

NOTE

Exact adjustment is very important if repeatable rise times are to be obtained in both +UP and —UP operations of the vertical plug-in.

5-35. GATE AMPLIFIER RESPONSE. This adjustment is applicable only when using group A plug-ins at fast sweep speeds. Perform gate amplifier response adjustment as follows:

a. Set following controls as applicable:

DISPLAY	INT
Main Time/Div	0.1 μs
Main Vernier	CAL
Sweep Mode	AUTO
Sweep Display	MAIN
Delayed Time/Div	OFF

b. Set monitor oscilloscope controls as follows:

Volts/Div	0.2
Time/Div	0.1 μs
Trigger Source	INT
Slope	+
Coupling	DC

c. Using 50:1 divider probe and monitor oscilloscope, observe signal at collector of A3Q3 (see figure 5-12 and figure 5-13).

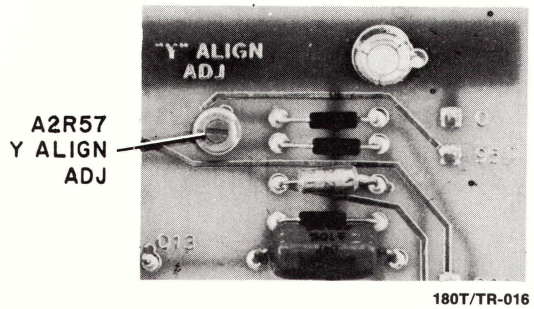


Figure 5-11. Y Alignment Adjustment Location

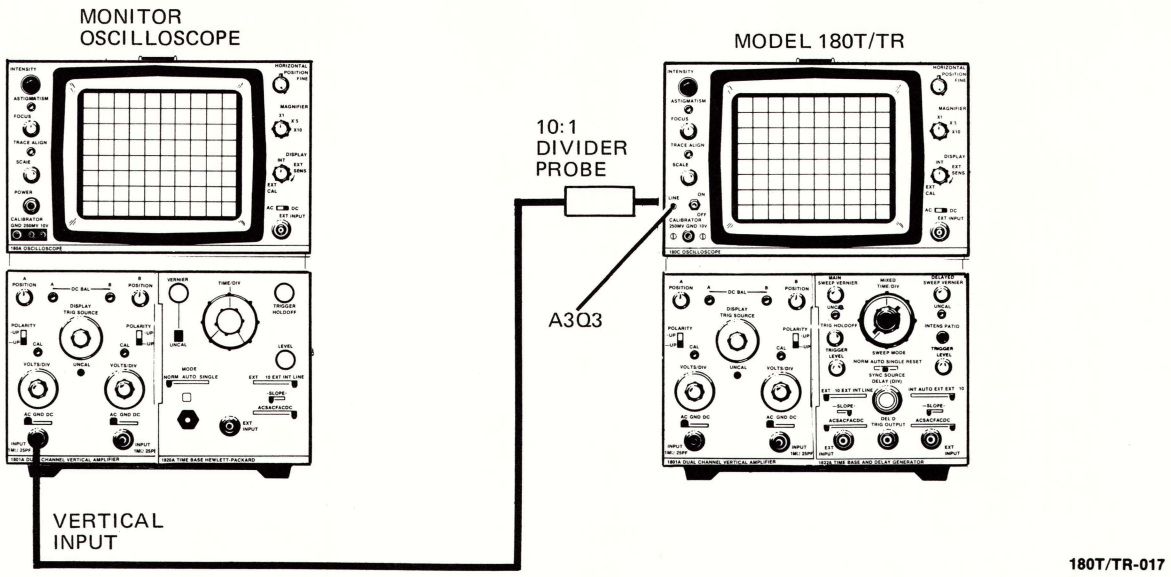


Figure 5-12. Gate Amplifier Response Test Setup

d. Rotate INTENSITY control cw for gate amplitude of 6 divisions (approximately 60 V).

e. Adjust Gate Resp Adj No. 2, A3C5, and Gate Resp Adj No. 1, A3C3, for optimum fast rise time and pulse flat-top response.

f. Disconnect monitor oscilloscope.

5-36. DC BALANCE. This adjustment is applicable when using either group A or group B plug-ins. Perform dc balance adjustment as follows:

a. Set MAGNIFIER to X10.

b. Set DISPLAY to EXT.

c. Center spot with POSITION control.

d. Set MAGNIFIER to X1.

e. Adjust DC Bal Adj, A2R38, to recenter spot (see figure 5-14).

f. Repeat steps a through e until spot does not shift from center while switching MAGNIFIER from X1 to X10.

5-37. VERNIER BALANCE. This adjustment is applicable when using either group A or group B plug-ins. Perform vernier balance adjustment as follows:

a. Set MAGNIFIER to X1.

b. Rotate EXT VERNIER from CAL position to fully ccw.

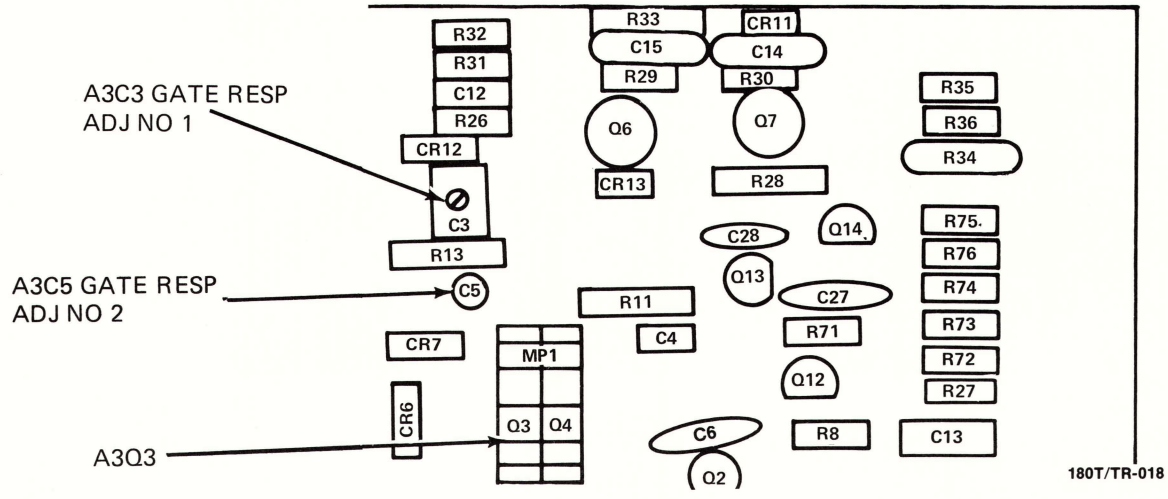


Figure 5-13. Gate Amplifier Adjustment Location

Figure 5-14. DC BAlance Adjustment Location

c. Center spot with POSITION control.

d. Set EXT VERNIER to CAL.

e. Adjust Vern Bal Adj, A2R14, to recenter spot (see figure 5-15).

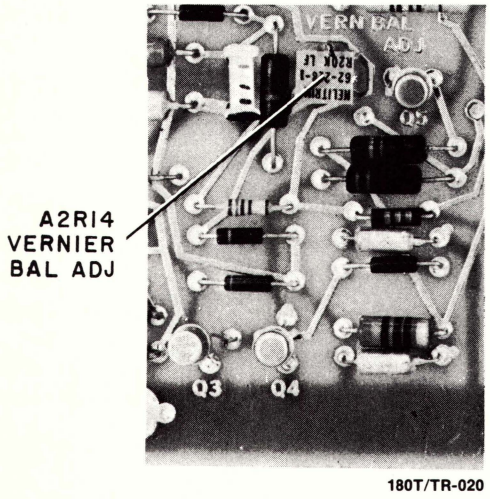


Figure 5-15. Vernier BAlance Adjustment Location

f. Repeat steps b through e until spot does not shift from center when EXT VERNIER is rotated.

5-38. HORIZONTAL GAIN. This adjustment is applicable when using either group A or group B plug-ins but critical only to interchangeability of group A time bases. When using group B plug-ins, gain is not critical and adjustment may be accomplished by inserting any known peak-to-peak voltage into EXT HORIZONTAL INPUT. Perform horizontal gain adjustment as follows:

a. Set controls as follows:

HORIZONTAL DISPLAY	EXT
HORIZONTAL MAGNIFIER	X1
EXT VERNIER	CAL

b. Check +100 V supply for +100 V ±0.1 V.

c. Connect 40-kilohm 0.1% 1/2 W resistor between +100 V supply and emitter of A5Q3. Keep connection lead length short as possible to avoid stray pick-up or oscillations.

CAUTION

With resistor disconnected, +100 V is present at open lead of resistor. Do not leave resistor connected throughout adjustment as thermal rise will shift current reference.

d. Adjust HORIZONTAL POSITION to center left-hand spot exactly on left-hand (first) vertical graticule line.

e. While alternately connecting and disconnecting resistor to emitter of A5Q3, adjust X1 Gain Adj, A5R46, for exactly 10-major divisions of separation between spot positions (see figure 5-16 and figure 5-17).

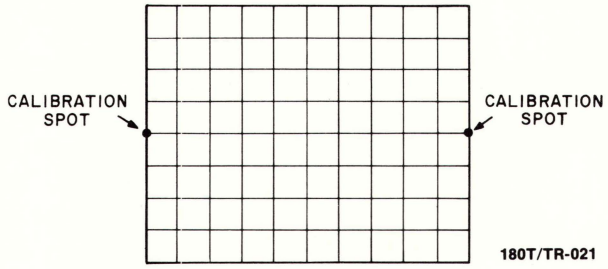


Figure 5-16. Calibration Display

f. Set HORIZONTAL DISPLAY to INT and plug-in for 1 ms/div sweep speed.

g. Apply 1-ms markers from time-mark generator to input of vertical plug-in.

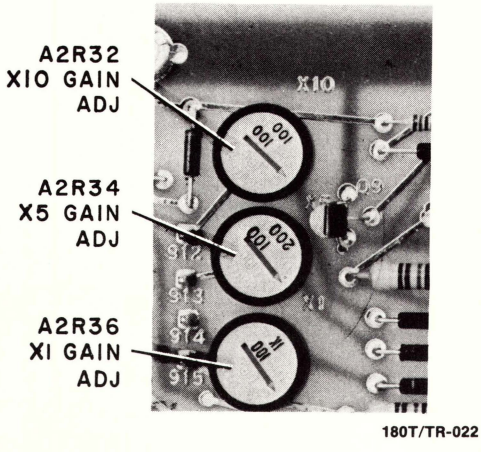


Figure 5-17. Gain Adjustment Location

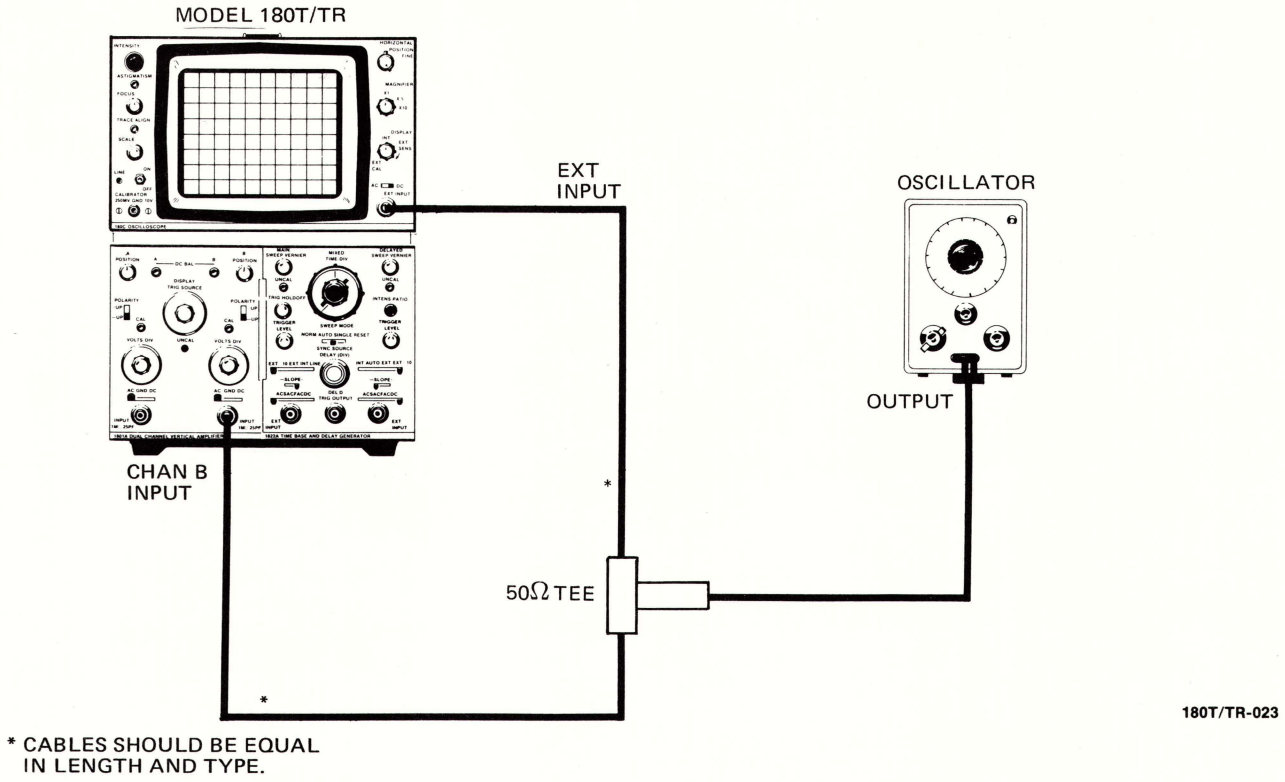


Figure 5-18. Phase Adjustment Test Setup

h. Adjust plug-in timing for 1 ms/div to obtain precisely one marker per division.

i. Set HORIZONTAL MAGNIFIER to X5.

j. Adjust X 5 Gain Adj, A2R34, to obtain precisely one marker per each 5 divisions.

h. Set HORIZONTAL MAGNIFIER to X10.

l. Adjust X10 Gain Adj, A2R32, to obtain display of precisely one marker for each 10 divisions.

m. Disconnect time-mark generator.

n. Disconnect 40-kilohm resistor from +100 V supply.

5-39. PHASE ADJUSTMENT. This adjustment is applicable only when using group A plug-ins for X-Y application. Perform phase adjustment as follows:

a. Set controls as follows:

Phase/Bandwidth Switch	Phase
HORIZONTAL MAGNIFIER	X1
HORIZONTAL DISPLAY	EXT
EXT VERNIER	CAL

b. Connect 10-kHz sine-wave output of test oscillator to HORIZONTAL EXT INPUT and to vertical plug-in channel B input (see figure 5-18).

c. Adjust test oscillator output to obtain 8-div display.

d. Adjust Input Comp Adj, A2C6, for display of single diagonal line (see figure 5-19).

e. Set test oscillator for output of 100-kHz sine wave.

f. Adjust Phase Adj, A2C8, for display of single diagonal line (no phase shift).

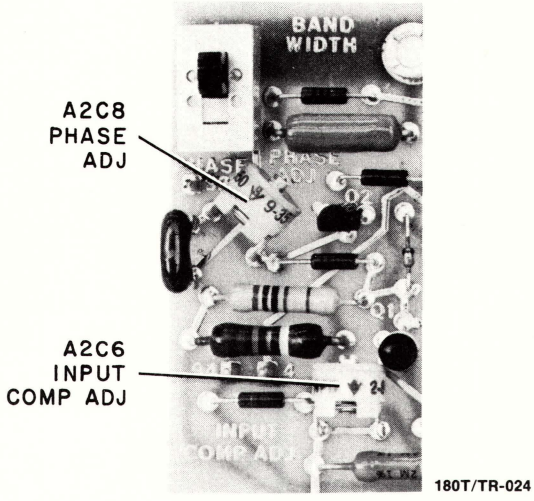


Figure 5-19. Phase and Input Adjustment Location

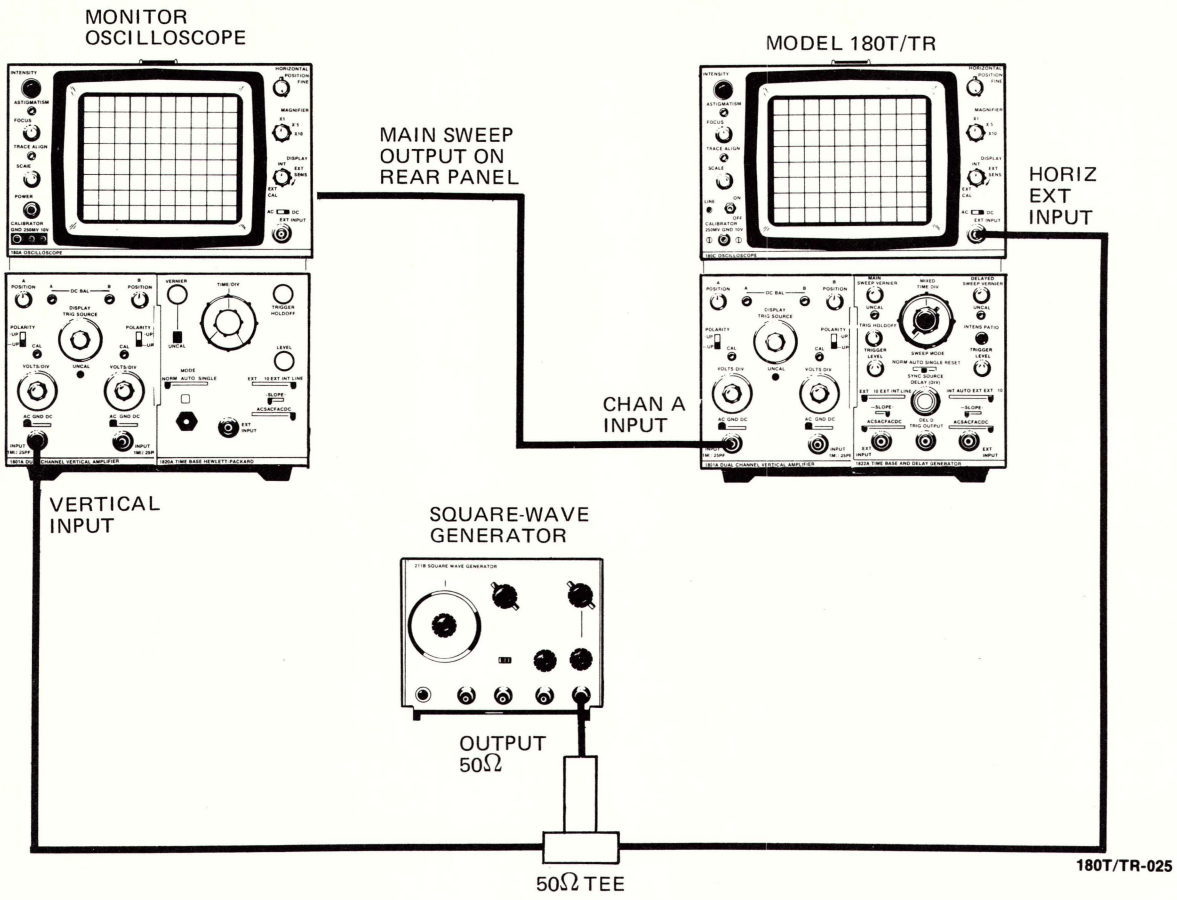


Figure 5-20. Transient Response Test Setup

g. Repeat steps b through f until no phase shift occurs for either frequency.

h. Disconnect test oscillator.

i. Return Phase/Bandwidth switch to Bandwidth position.

5-40. TRANSIENT RESPONSE. This adjustment is applicable when using group A plug-ins and only after major repairs or complete board replacement has been made. Omit this adjustment procedure for normal calibration and perform the Horizontal Linearity adjustment.

a. Use test setup (figure 5-20).

b. Set DISPLAY to EXT CAL.

c. Connect main sweep output from monitor oscilloscope to vertical input of Model 180T/TR.

d. Adjust vertical plug-in VOLTS/DIV and vernier controls to obtain 8-div display.

e. Connect 1-V p-p square wave at 200-kHz repetition rate from square-wave generator to HORIZONTAL EXT INPUT and to monitor oscilloscope vertical input.

f. Set monitor oscilloscope to operate at 1 μs div and synchronize monitor oscilloscope with 200-kHz signal.

g. Using POSITION controls and varying frequency of square-wave generator, position lower right-hand corner of sideways square wave so that it is on screen.

h. At this stage of adjustment, waveform will typically exhibit 5% (approximately 1/2 div) overshoot. If overshoot is greater, adjust HF Adj No. 1, A2C12, HF Adj No. 2 A2C21, and HF Adj No. 3, A2C20 to obtain flat-top response with approximately 5% overshoot on lower right-hand corner of displayed pulse.

NOTE

Capacitors for HF Adj No. 1, A2C12, and HF Adj No. 3, A2C20 should be adjusted so their slugs are equally extended.

5-41. HORIZONTAL LINEARITY. This adjustment is applicable only when using group A plug-ins at fast sweep speeds. Before proceeding with this adjustment check linearity and if magnified sweep timing is within specifications do not perform this adjustment. To perform horizontal linearity check proceed as follows:

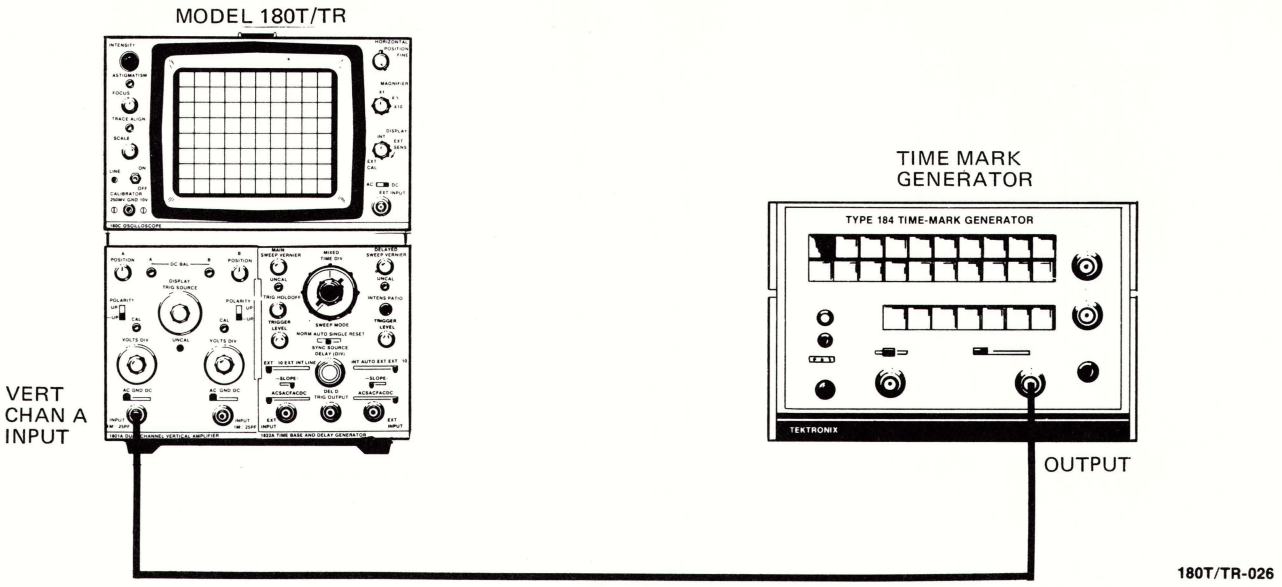


Figure 5-21. Horizontal Linearity Test Setup

NOTE

Ensure that time base has been properly calibrated before proceeding with this adjustment.

a. Set HORIZONTAL DISPLAY to INT.

b. Connect 4-V p-p, 50-MHz sine-wave output from time-mark generator to vertical input (see figure 5-21).

c. Set HORIZONTAL MAGNIFIER to X10.

d. Select fastest sweep speed (.05 or .1 μs/div) and obtain display.

e. Adjust HF Adj No. 1, A2C12, No. 2, A2C21, and No. 3, A2C20, for best overall linearity of center 80 divisions of available display. Use HORIZONTAL POSITION control to permit viewing right, center, and left portions of display. HF Adj No. 1 affects right potion, HF Adj No. 2, center portion, and HF Adj No. 3, left portion of sweep (see figure 5-22).

5-42. This completes the adjustment procedure. If desired, the instrument performance may be tested to specifications using the Performance Check procedure. If satisfactory adjustment or instrument performance is not obtained refer to Section VIII of this manual for troubleshooting information.

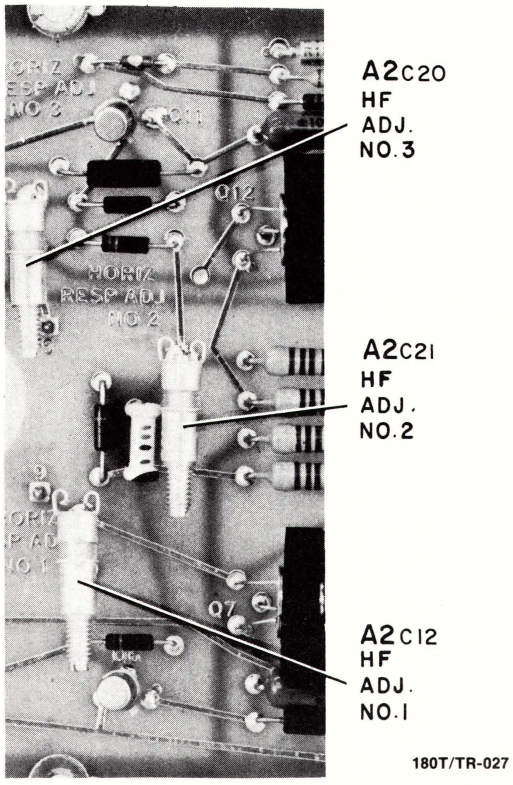


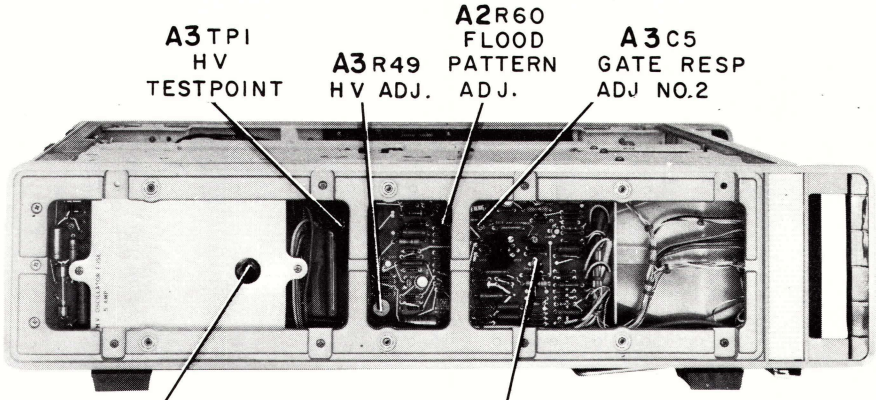
Figure 5-22. Linearity Adjustment Location.

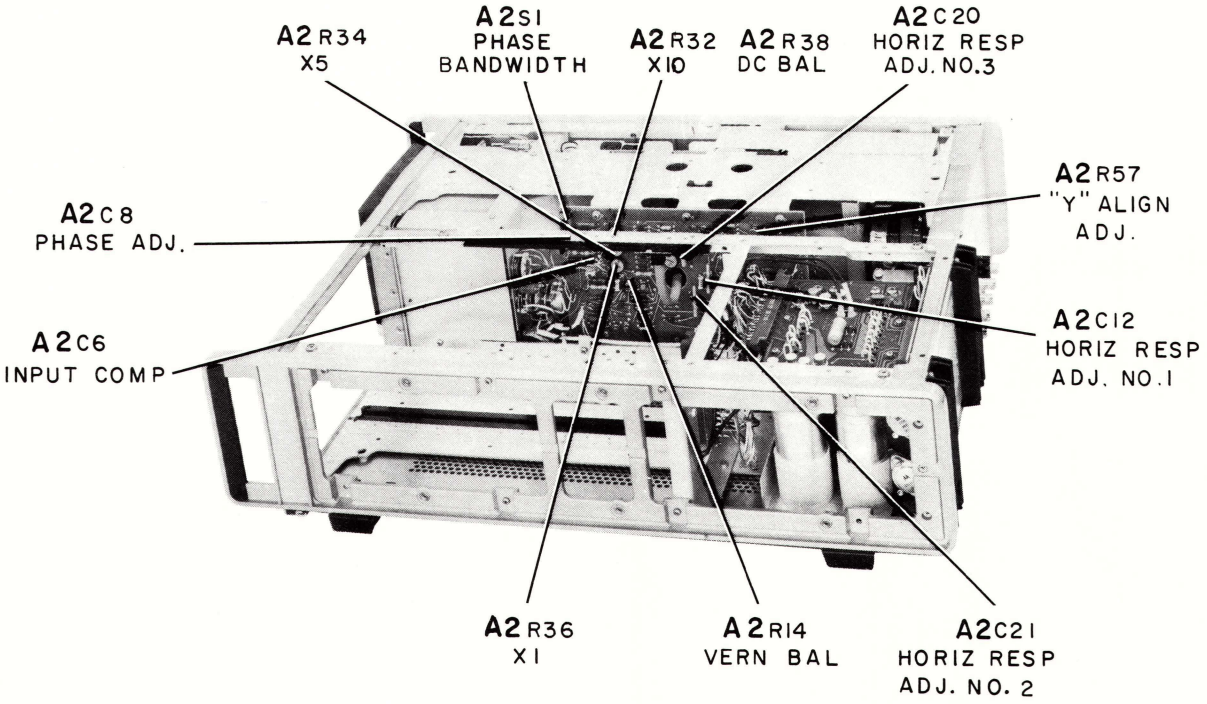
PERFORMANCE CHECK RECORD

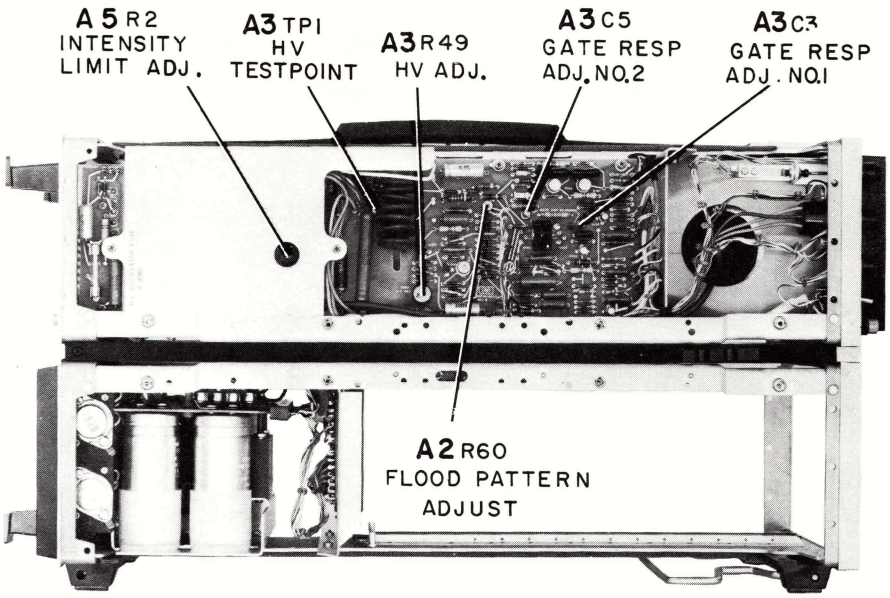
MODEL 180T/TR

Instrument Serial Number _____ **Date** _____

Check	Specification	Measured
CALIBRATOR		
Amplitude	10 div ±0.1 div	_____
Rise Time	≤3 μs	_____
MAGNIFIER		
X1	10 div ±0.5 div	_____
X10	10 div ±0.5 div	_____
BANDWIDTH	≥7.1 div	_____
FIND BEAM	Intensified Beam on Screen	_____


A3TP1
HV
TESTPOINT
A3R49
HV ADJ.
A2R60
FLOOD
PATTERN
ADJ.
A3C5
GATE RESP
ADJ NO.2
A5R2
INTENSITY
LIMIT ADJ.
A3C3
GATE
RESP ADJ
NO.1


A2R34
X5
A2S1
PHASE
BANDWIDTH
A2R32
X10
A2R38
DC BAL
A2C20
HORIZ RESP
ADJ. NO.3
A2R57
"Y" ALIGN
ADJ.
A2C8
PHASE ADJ.
A2C12
HORIZ RESP
ADJ. NO.1
A2C6
INPUT COMP
A2R36
X1
A2R14
VERN BAL
A2C21
HORIZ RESP
ADJ. NO. 2



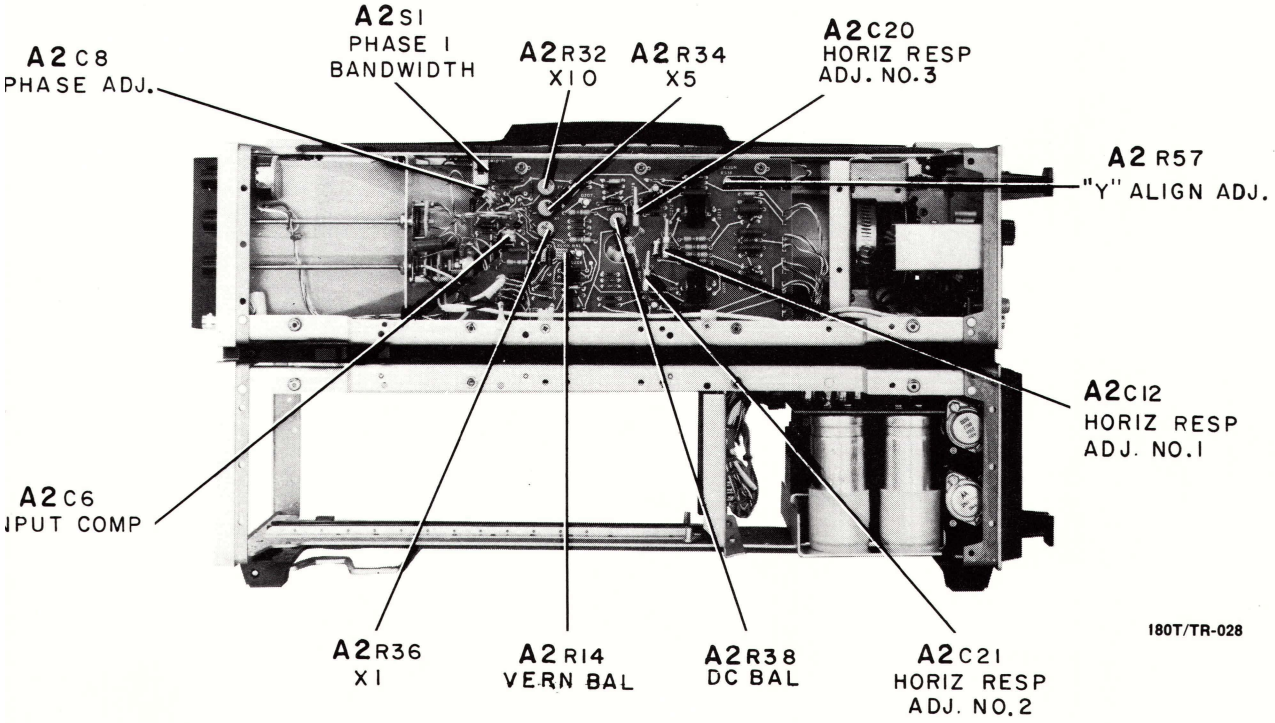


Figure 5-23.
Adjustment Locations

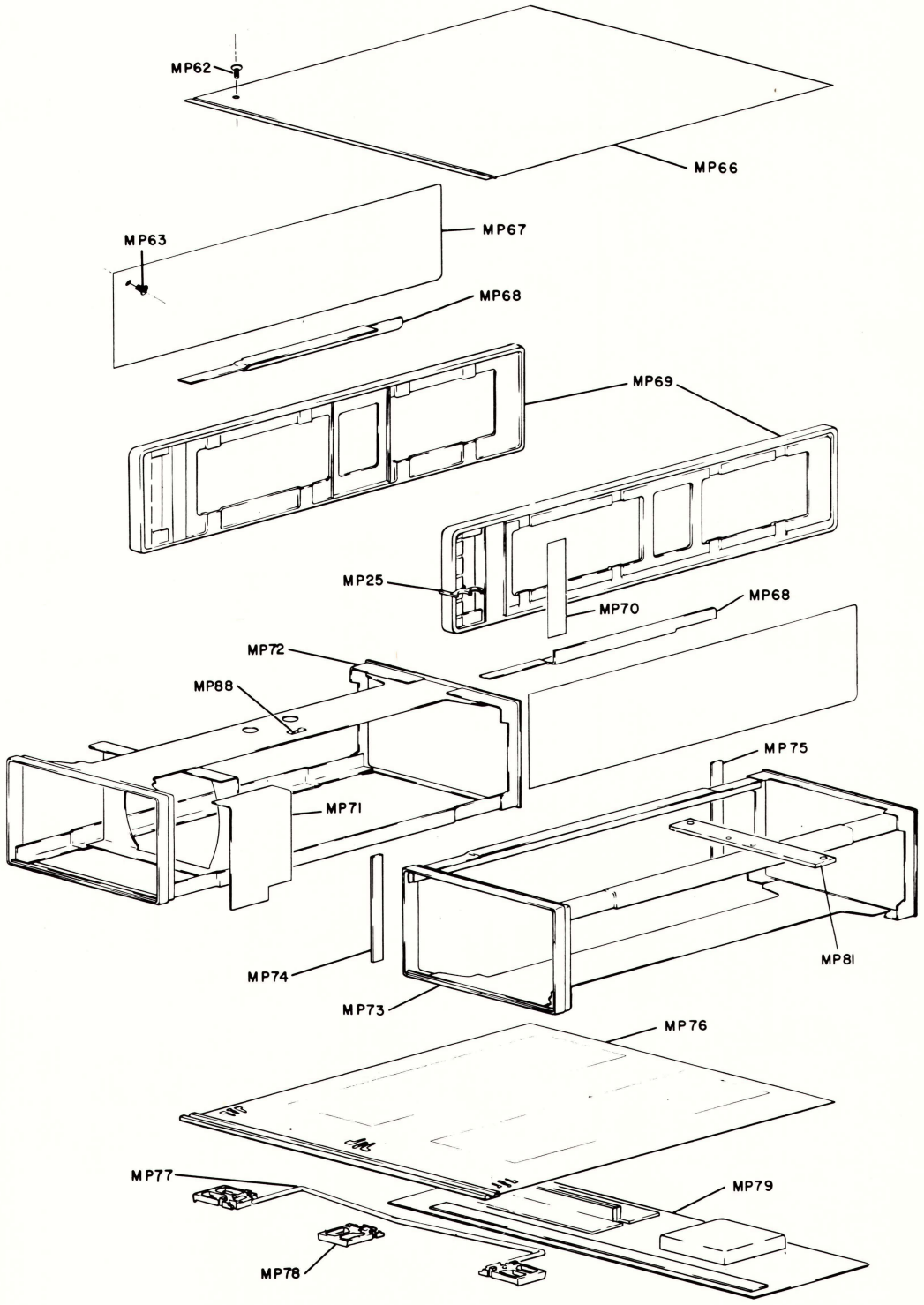
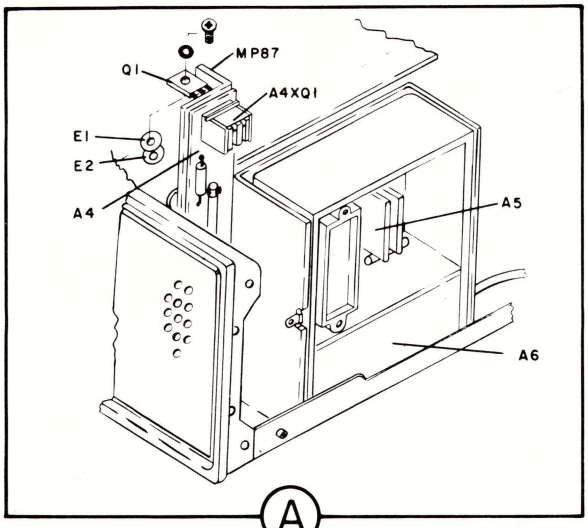
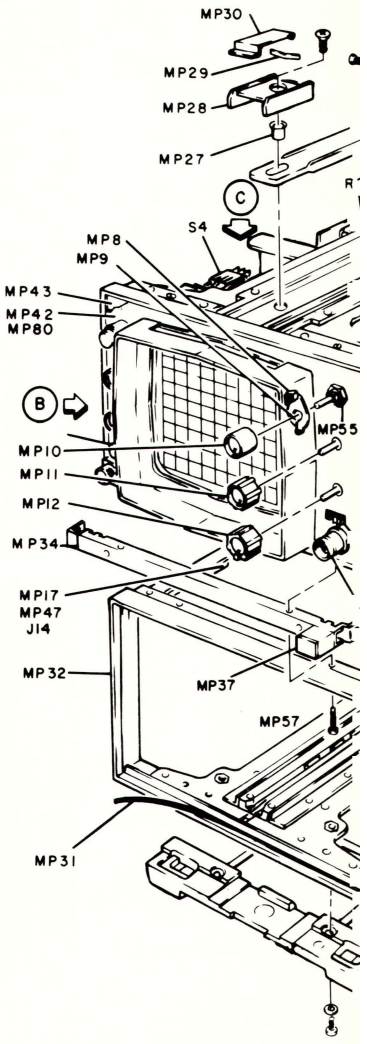
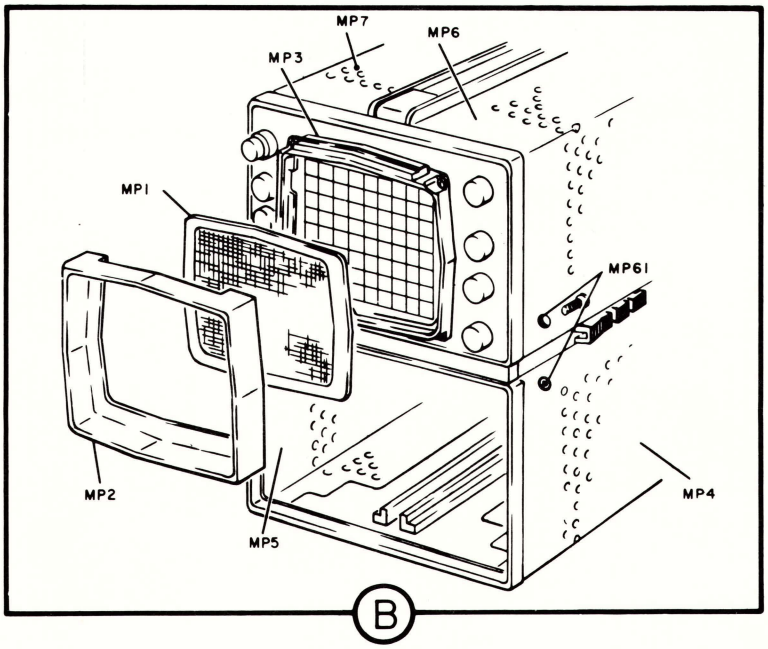
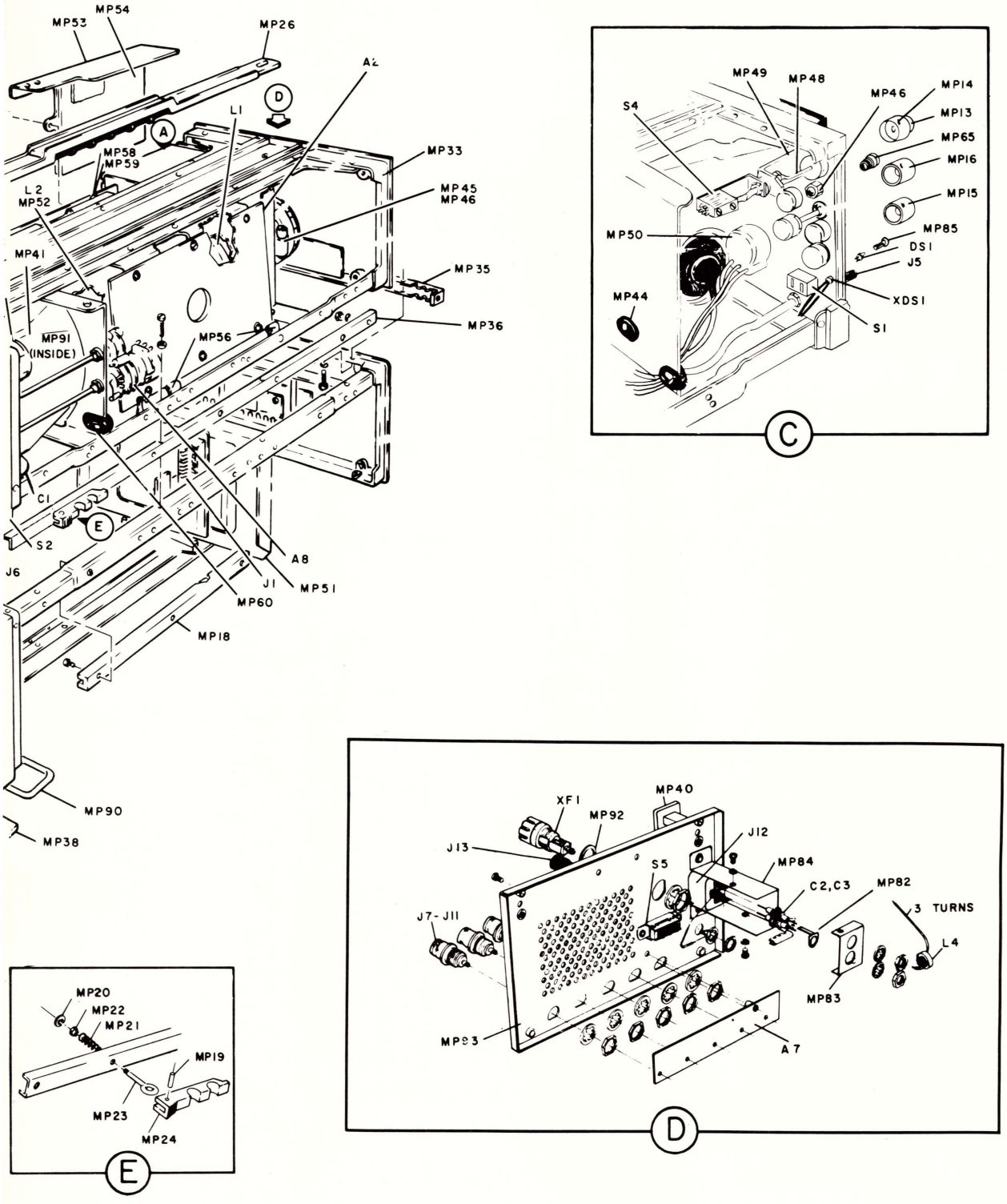


Figure 6-1. Model 180TR Mechanical Parts


MP87
Q1
A4XQ1
E1
E2
A4
A5
A6
A


MP30
MP29
MP28
MP27
C
S4
MP8
MP9
MP43
MP42
MP80
B
MP55
MP10
MP11
MP12
MP34
MP17
MP47
J14
MP32
MP37
MP57
MP31


MP7
MP6
MP3
MP1
MP61
MP2
MP5
MP4
B



180T/TR-030

Figure 6-2. Model 180T/TR Mechanical Parts

SECTION VI

REPLACEABLE PARTS

6-1. INTRODUCTION.

6-2. This section contains information for ordering replacement parts. The abbreviations used in the parts list are described in table 6-1. Table 6-2 lists the parts in alphanumeric order by reference designation and includes the manufacturer and manufacturer's part number. Table 6-3 contains the list of manufacturers' codes.

6-3. ORDERING INFORMATION.

6-4. To obtain replacement parts from Hewlett-Packard, address order or inquiry to the nearest Hewlett-Packard Sales/Service Office and supply the following information:

a. Instrument model and serial number.

b. HP part number of item(s).

c. Quantity of part(s) desired.

d. Reference designation of part(s).

6-5. To order a part not listed in the table, provide the following information:

a. Instrument model and serial number.

b. Description of the part, including function and location in the instrument.

c. Quantity desired.

Table 6-1. Abbreviations for Replaceable Parts List

A	AMPERE(S)	H	HENRY(IES)	NPN	NEGATIVE-POSITIVE-NEGATIVE	RWV	REVERSE WORKING VOLTAGE
ASSY	ASSEMBLY	HG	MERCURY				
		HP	HEWLETT-PACKARD	NSR	NOT SEPARATELY REPLACEABLE	S-B	SLOW-BLOW
BD	BOARD(S)	HZ	HERTZ			SCR	SILICON CONTROLLED RECTIFIER
BH	BINDER HEAD						
BP	BANDPASS	IF	INTERMEDIATE FREQ.			SE	SELENIUM
		IMPG	IMPREGNATED	OBD	ORDER BY DESCRIPTION	SEC	SECOND(S)
C	CENTI (10^{-2})	INCD	INCANDESCENT			SECT	SECTION(S)
CAR	CARBON	INCL	INCLUDE(S)	OH	OVAL HEAD	SI	SILICON
CCW	COUNTERCLOCKWISE	INS	INSULATION(ED)	OX	OXIDE	SIL	SILVER
CER	CERAMIC	INT	INTERNAL			SL	SLIDE
CMO	CABINET MOUNT ONLY			P	PEAK	SP	SINGLE POLE
COAX	COAXIAL	K	KILO (10^{3})	PC	PRINTED (ETCHED) CIRCUIT(S)	SPL	SPECIAL
COEF	COEFFICIENT	KG	KILOGRAM			ST	SINGLE THROW
COMP	COMPOSITION			PF	PICOFARADS	STD	STANDARD
CONN	CONNECTOR(S)	LB	POUND(S)	PHL	PHILLIPS		
CRT	CATHODE-RAY TUBE	LH	LEFT HAND	PIV	PEAK INVERSE VOLTAGE(S)	TA	TANTALUM
CW	CLOCKWISE	LIN	LINEAR TAPER			TD	TIME DELAY
		LOG	LOGARITHMIC TAPER	PNP	POSITIVE-NEGATIVE-POSITIVE	TFL	TEFLON
D	DECI (10^{-1})	LPF	LOW-PASS FILTER(S)			TGL	TOGGLE
DEPC	DEPOSITED CARBON	LVR	LEVER	P/O	PART OF	THYR	THYRISTOR
DP	DOUBLE POLE			PORC	PORCELAIN	TI	TITANIUM
DT	DOUBLE THROW	M	MILLI (10^{-3})	POS	POSITION(S)	TNLDIO	TUNNEL DIODE(S)
		MEG	MEGA (10^{6})	POT	POTENTIOMETER(S)	TOL	TOLERANCE
ELECT	ELECTROLYTIC	MET FILM	METAL FILM	P-P	PEAK-TO-PEAK	TRIM	TRIMMER
ENCAP	ENCAPSULATED	MET OX	METAL OXIDE	PRGM	PROGRAM		
EXT	EXTERNAL	MFR	MANUFACTURER	PS	POLYSTYRENE		
		MINAT	MINIATURE	PWV	PEAK WORKING VOLTAGE	U	MICRO (10^{-6})
F	FARAD(S)	MOM	MOMENTARY				
FET	FIELD-EFFECT TRANSISTOR(S)	MTG	MOUNTING			V	VOLTS
		MY	MYLAR	RECT	RECTIFIER(S)	VAR	VARIABLE
FH	FLAT HEAD			RF	RADIO FREQUENCY	VDCW	DC WORKING VOLT(S)
FIL H	FILLISTER HEAD	N	NANO (10^{-9})	RFI	RADIO FREQUENCY INTERFERENCE		
FXD	FIXED	N/C	NORMALLY CLOSED			W	WATT(S)
		NE	NEON	RH	ROUND HEAD OR RIGHT HAND	W/	WITH
G	GIGA (10^{9})	N/O	NORMALLY OPEN			WIV	WORKING INVERSE VOLTAGE
GE	GERMANIUM	NOP	NEGATIVE POSITIVE ZERO (ZERO TEMPERATURE COEFFICIENT)				
GL	GLASS			RMO	RACK MOUNT ONLY	W/O	WITHOUT
GRD	GROUNDED			RMS	ROOT MEAN SQUARE	WW	WIREWOUND

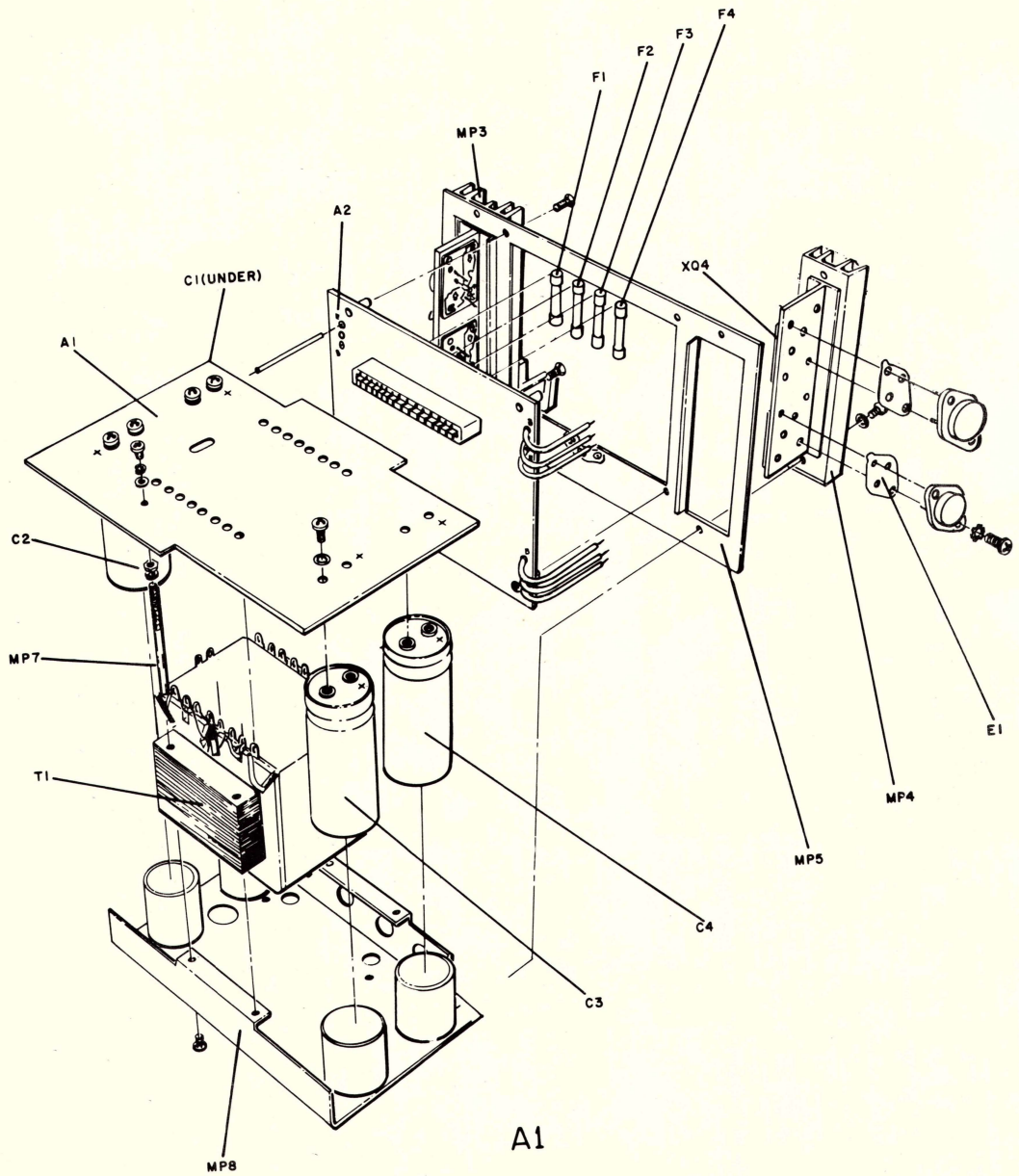


Figure 6-3. Low Voltage Power Module Exploded View

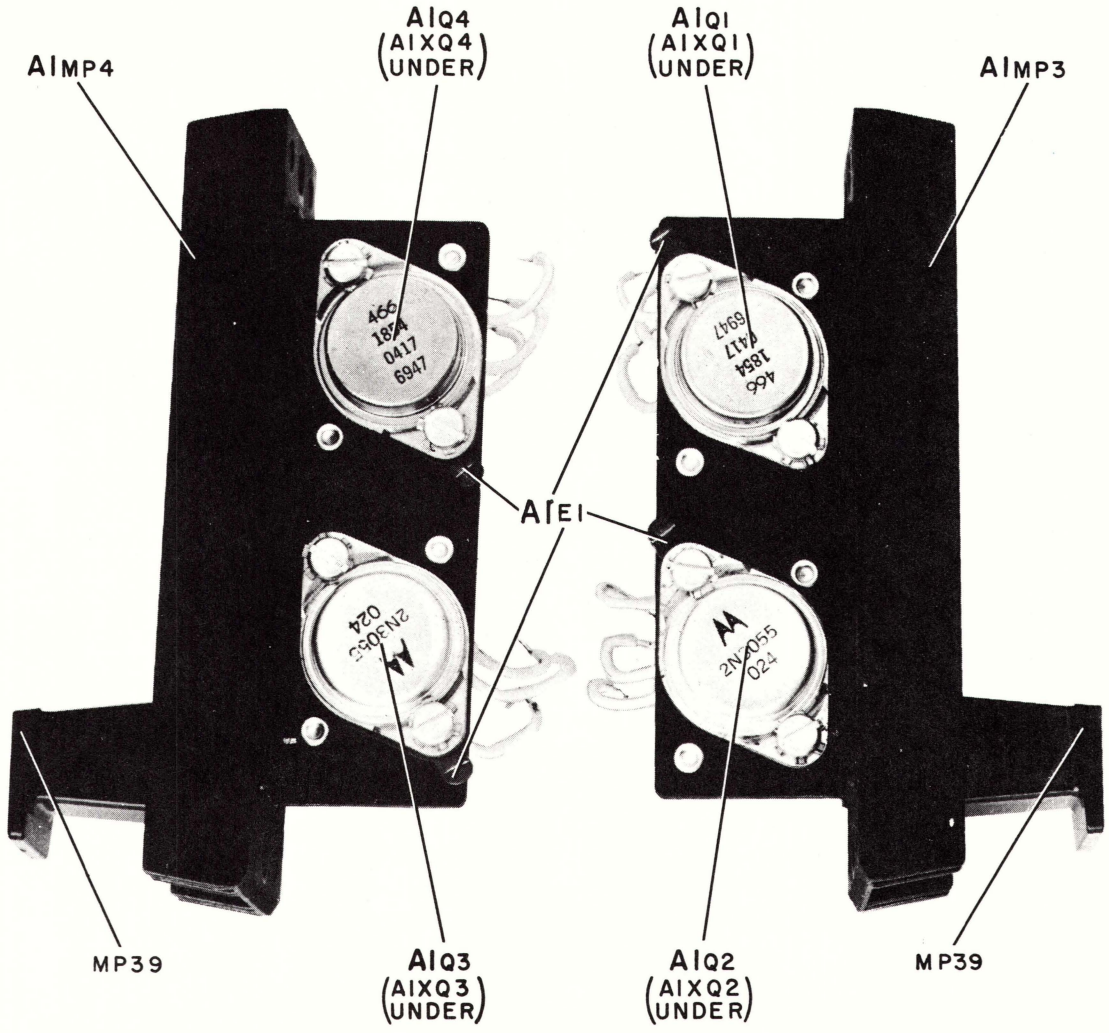


Figure 6-4. Series Regulator Parts Identification

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1	00184-60003	1	POWER MODULE:LOW VOLTAGE	28480	00184-60003
A1C1	0180-1807	2	C:FXD ELECT 290 UF +50–10% 200 VDCW	56289	32D291F200AB2A-DQB
A1C2	0180-1865	1	C:FXD ELECT 2100 UF +75–10% 40 VDCW	56289	32D212G040AB2A-DQB
A1C3	0180-1809	1	C:FXD ELECT 3400 UF +75–10% 25 VDCW	56289	32D342G025AB2A-DQB
A1C4	0180-1807		C:FXD ELECT 290 UF +50 -10% 200 VDCW	56289	32D291F200AB2A-DQB
A1E1	1200-0043	4	INSULATOR:TSTR MOUNTING (TO-3)	71785	293011
A1MP3	00180-61103	1	TRANSISTOR:HEAT SINK RH	28480	00180-61103
A1MP4	00180-61104	1	TRANSISTOR:HEAT SINK LH	28480	00180-61104
A1MP5	00180-00249	1	PANEL:REAR	28480	00180-00249
A1MP7	00182-24701	4	SPACER:LVPS	28480	00182-24701
A1MP8	00180-01252	1	BRACKET:TRANSFORMER	28480	00180-01252
A1Q1	1854-0417	2	TSTR:SI NPN	28480	1854-0417
A1Q2	1854-0063	2	TSTR:SI NPN	80131	2N3055
A1Q3	1854-0063		TSTR:SI NPN	80131	2N3055
A1Q4	1854-0417		TSTR:SI NPN	28480	1854-0417
A1T1	9100-3401	1	TRANSFORMER:POWER	28480	9100-3401
A1XQ1 THRU A1XQ4	1200-0041	4	SOCKET:TRANSISTOR	71785	133-32-10-013
A1A1	00184-66511	1	ASSY:LOW VOLTAGE RECTIFIER BOARD	28480	00184-66511
A1A1C1	0180-0091	1	C:FXD ELECT 10 UF +50–10% 100 VDCW	56289	30D106F100DC2-USM
A1A1CR1 THRU A1A1CR8	1901-0028		DIODE:SILICON 0.75A 400 PIV	04713	SR1358-9
A1A1CR9 THRU A1A1CR16	1901-0415	8	DIODE:SILICON 50 PIV 3A	28480	1901-0415
A1A1CR17 THRU A1A1CR20	1901-0028		DIODE:SILICON 0.75A 400 PIV	04713	SR1358-9
A1A1CR21	1901-0045	2	DIODE:SILICON 0.75A 100 PIV	04713	SR1358-7
A1A1CR22	1901-0045		DIODE:SILICON 0.75A 100 PIV	04713	SR1358-7
A1A1R1	0687-1041		R:FXD COMP 100K OHM 10% 1/2W	01121	EB1041
A1A1R2	0687-1041		R:FXD COMP 100K OHM 10% 1/2W	01121	EB1041
A1A1R3	0760-0016		R:FXD MET OX 2.7K OHM 2% 1W	28480	0760-0016
A1A1R4	0757-0060		R:FXD MET FLM 24.3K OHM 1% 1/2W	28480	0757-0060
A1A1VR1	1902-0597		DIODE:BREAKDOWN 56.2V 5% 1W	28480	1902-0597
A1A2	00184-66509		ASSY:LOW VOLTAGE REGULATOR BOARD	28480	00184-66509
A1A2C1	0140-0176		C:FXD MICA 100 PF +- 2% 300 VDCW	72136	DM15F101G0300WICR
A1A2C2	0180-0269	1	C:FXD ELECT 1.0 UF +50–10% 150 VDCW	56289	30D105F150BA2-DSM
A1A2C3	0180-0089	3	C:FXD AL ELECT 10 UF +50 10% 150 VDCW	56289	30D106F150DD2-DSM
A1A2C4	0160-0161		C:FXD MY 0.01 UF 10% 200 VDCW	56289	192P10392-PTS
A1A2C5	0180-0058	2	C:FXD AL ELECT 50 UF +75–10% 25 VDCW	56289	30D506G025CC2-DSM
A1A2C6	0170-0040	3	C:FXD MY 0.047 UF 10% 200 VDCW	56289	192P47392-PTS
A1A2C7	0180-0058		C:FXD AL ELECT 50 UF +75–10% 25 VDCW	56289	30D506G025CC2-DSM
A1A2C9	0180-0089		C:FXD AL ELECT 10 UF +50–10% 150 VDCW	56289	30D106F150DD2-DSM
A1A2CR1	1901-0040	16	DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A1A2CR2	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A1A2CR3	1901-0026	2	DIODE:SILICON 0.75A 200 PIV	04713	SR1358-8
A1A2CR4	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A1A2CR5	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A1A2CR6	1901-0040		DIODE:SILICON 30 MA 30 WV		
A1A2CR7	1901-0026		DIODE:SILICON 0.75A 200 PIV	04713	SR1358-8
A1A2E1 THRU A1A2E8	2110-0269		CLIP:FUSE 0.250" DIA	91506	6008-32CN
A1A2F1	2110-0065	2	FUSE:0375A 250V	75915	312.375
A1A2F2	2110-0002	2	FUSE:CARTRIDGE 2 AMP 3 AG	75915	312.002
A1A2F3	2110-0002		FUSE:CARTRIDGE 2 AMP 3 AG	75915	312.002
A1A2F4	2110-0065		FUSE:0375A 250V	75915	312.375
A1A2J3	1251-1633	1	CONNECTOR:PC 15 CONTACT	71785	252-15-30-310
A1A2Q1	1854-0234		TSTR:SI NPN	80131	2N3440
A1A2Q2 THRU A1A2Q4	1854-0071	16	TSTR:SI NPN	28480	1854-0071
A1A2Q5	1854-0039		TSTR:SI NPN	80131	2N3053
A1A2Q6 THRU A1A2Q8	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2Q9	1854-0039		TSTR:SI NPN	80131	2N3053
A1A2Q10	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2Q11	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2Q12	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2Q13	1854-0039		TSTR:SI NPN	80131	2N3053
A1A2Q14	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2Q15	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2Q16	1854-0071		TSTR:SI NPN	28480	1854-0071
A1A2R1	0757-0713	1	R:FXD FLM 110 OHM 1% 1/4W	28480	0757-0713
A1A2R2	0757-0281	6	R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A1A2R3	0757-0465	3	R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A1A2R4	0812-0058	2	R:FXD WW 0.2 OHM 5% 2W	28480	0812-0058
A1A2R5	0757-0060	2	R:FXD MET FLM 24.3K OHM 1% 1/2W	28480	0757-0060
A1A2R6	0757-0060		R:FXD MET FLM 24.3K OHM 1% 1/2W	28480	0757-0060
A1A2R7	0757-0435	4	R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435
A1A2R8	0757-0438	9	R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1A2R9	0757-0044	2	R:FXD MET FLM 33.2K OHM 1% 1/2W	28480	0757-0044
A1A2R10	0757-0435		R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A1A2R11	2100-1773	2	R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A1A2R12	0757-0767	3	R:FXD FLM 43.2K OHM 1% 1/4W	28480	0757-0767
A1A2R13	0811-1746	2	R:FXD WW 0.36 OHM 5% 2W	28480	0811-1746
A1A2R14	0757-0767		R:FXD FLM 43.2K OHM 1% 1/4W	28480	0757-0767
A1A2R15	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1A2R16	0757-0767		R:FXD FLM 43.2K OHM 1% 1/4W	28480	0757-0767
A1A2R17	0757-0431	3	R:FXD MET FLM 2.43K OHM 1% 1/8W	28480	0757-0431
A1A2R18	0757-0273	1	R:FXD MET FLM 3.01K	28480	0757-0273
A1A2R19	0757-0283	7	R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A1A2R20	2100-1772	2	R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1772
A1A2R21	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A1A2R22	0811-1746		R:FXD WW 0.36 OHM 5% 2W	28480	0811-1746
A1A2R23	0757-0769	3	R:FXD FLM 51.5K OHM 1% 1/4W	28480	0757-0769
A1A2R24	0757-0436	3	R:FXD MET FLM 4.32K OHM 1% 1/8W	28480	0757-0436
A1A2R25	0757-0430	1	R:FXD MET FLM 2.21K OHM 1% 1/8W	28480	0757-0430
A1A2R26	0757-0769		R:FXD FLM 51.1K OHM 1% 1/4W	28480	0757-0769
A1A2R27	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A1A2R28	0757-0428	2	R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A1A2R29	2100-1722		R:VAR WW 500 OHM 5% TYPE H 1W	28480	2100-1722
A1A2R30	0757-0435		R:FXD FLM 3920 OHM 1% 1/8W	28480	0757-0435
A1A2R31	0757-0367	3	R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
A1A2R32	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A1A2R33	0812-0058		R:FXD WW 8.2 OHM 5% 2W	28480	0812-0058
A1A2R34	0757-0769		R:FXD FLM 51.5K OHM 1% 1/4W	28480	0757-0769
A1A2R35	0757-0768	2	R:FXD FLM 47.5K OHM 1% 1/4W	28480	0757-0768
A1A2R36	0757-0044		R:FXD MET FLM 33.2K OHM 1% 1/2W	28480	0757-0044
A1A2R37	0757-0367		R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
A1A2R38	0757-0450	1	R:FXD MET FLM 22.1K OHM 1% 1/8W	28480	0757-0450
A1A2R39	0757-0280	8	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A1A2R40	2100-1774	1	R:VAR WW 2K OHM 5% TYPE H 1W	28480	2100-1774
A1A2R41	0757-0768		R:FXD FLM 47.5K OHM 1% 1/4W	28480	0757-0768
A1A2R42	0687-5611		R:FXD COMP 560 OHM 10% 1/2W	01121	EB5611
A1A2TP1 THRU A1A2TP4	1251-0206	5	CONNECTOR:SOCKET 0.15 DDY DIA TEFLON	98291	SKT-400
A1A2VR1	1902-3096	1	DIODE BREAKDOWN: 5.23V 5% 400 MW	28480	1902-3096
A1A2VR2	1902-0787	1	DIODE:T.C. REFERENCE 1N938	04713	1N938
A2	00180-66543	1	BOARD ASSY:HORIZONTAL AMPLIFIER	28480	00180-66543
A2C1	0160-0162	13	C:FXD MY 0.022 UF 10% 200 VDCW	56289	192P22392-PTS
A2C2	0160-0162		C:FXD MY 0.022 UF 10% 200 VDCW	56289	192P22392-PTS
A2C3	0180-0197	4	C:FXD ELECT 2.2 UF 10% 20 VDCW	56289	150D225X9020A2-DYS
A2C4	0180-0197		C:FXD ELECT 2.2 UF 10% 20 VDCW	56289	150D225X9020A2-DYS
A2C5	0160-0162		C:FXD MY 0.022 UF 10% 200 VDCW	56289	192P22392-PTS
A2C6	0121-0059	1	C:VAR CER 2-8 PF 300 VDCW	28480	0121-0059
A2C7	0160-2250	1	C:FXD 5.1 PF 500 VDCW	72982	301-000-COHO-519E
A2C8	0121-0105	1	C:VAR CER 9-35 PF NPO	28480	0121-0105
A2C9	0140-0205	1	C:FXD MICA 62 PF 5% 300 VDCW	00853	RDM15E620J3C
A2C10	0160-0162		C:FXD MY 0.022 UF 10% 200 VDCW	56289	192P22392-PTS
A2C11	0160-0162		C:FXD MY 0.022 UF 10% 200 VDCW	56289	192P22392-PTS
A2C12	0132-0007	3	C:VAR POLY 0.7 TO 3.0 PF 350 VDCW	72982	535-033-4R
A2C13	0170-0040		C:FXD MY 0.047 UF 10% 200 VDCW	56289	192P47392-PTS
A2C14	0160-0162		C:FXD MY 0.022 UF 10% 200 VDCW	56289	192-P22392-PTS
A2C15	0180-0197		C:FXD ELECT 2.2 UF 10% 20 VDCW	56289	150D225X9020A2-DYS
A2C16	0180-0197		C:FXD ELECT 2.2 UF 10% 20 VDCW	56289	150D225X9020A2-DYS
A2C17	0180-0218	1	C:FXD ELECT 0.15 UF 10% 35 VDCW	28480	0180-0218
A2C18	0160-0162		C:FXD MY 0.022 UF 10% 200 VDCW	56289	192P22392-PTS
A2C19	0170-0040		C:FXD MY 0.047 UF 10% 200 VDCW	56289	192P47392-PTS
A2C20	0132-0007		C:VAR POLY 0.7 TO 3.0 PF 350 VDCW	72982	535-033-4R
A2C21	0132-0007		C:VAR POLY 0.7 TO 3.0 PF 350 VDCW	72982	535-033-4R
A2C22	0160-2235	1	C:FXD CER 0.75 PF 500 VDCW	72982	301-000-COKO-758C
A2CR1	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A2CR2	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A2CR3	5080-0464	4	DIODE:SILICON 30 200 M	28480	5080-0464
A2CR4	5080-0464		DIODE:SILICON 30 200 M	28480	5080-0464
A2CR5	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A2CR6	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A2CR7	5080-0464		DIODE:SILICON 30 200 M	28480	5080-0464
A2CR8	5080-0464		DIODE:SILICON 30 200 M	28480	5080-0464
A2CR9	1901-0040		DIODE:SILICON 30 MA 30 WV	07263	FDG1088
A2E1	0360-1514	75	PIN:SQUARE	28480	0360-1514
A2L1	9140-0179	7	COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A2L2	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A2L3	9170-0029	1	CORE:FERRITE BEAD	02114	56-590-65A2/4A
A2MP1	1205-0063	3	HEAT SINK:SEMICONDUCTOR	05820	224-CB
A2Q1	1855-0062	1	TSTR:SI FET 30V	01295	2N1595
A2Q2	1854-0215	1	TSTR:SI NPN	80131	2N3904
A2Q3	1850-0158	1	TSTR:GE PNP	80131	2N2635
A2Q4	1854-0019	5	TSTR:SI NPN	28480	1854-0019
A2Q5	1854-0019		TSTR:SI NPN	28480	1854-0019
A2Q6	1853-0009	3	TSTR:SI PNP	28480	1853-0009
A2Q7	1854-0419	2	TSTR:SI NPN	04713	SS657
A2Q8	1853-0038	3	TSTR:SI PNP	28480	1853-0038
A2Q9	1854-0071		TSTR:SI NPN	28480	1854-0071
A2Q10	1854-0019		TSTR:SI NPN	28480	1854-0019
A2Q11	1853-0009		TSTR:SI PNP	28480	1853-0009

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A2Q12	1854-0419		TSTR:SI NPN	04713	SS657
A2Q13	1853-0038		TSTR:SI PNP	28480	1853-0038
A2R1	0757-0401	9	R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R2	0683-0275	5	R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A2R3	0757-0388	1	R:FXD FLM 30.1 OHM 1% 1/8W	28480	0757-0388
A2R4	0757-0287	1	R:FXD CARBON 2 MEGOHM 1% 1/2W	28480	0757-0287
A2R5	0757-0156	1	R:FXD MET FLM 1.5 MEGOHM 1% 1/2W	28480	0757-0156
A2R6	0757-0344	1	R:FXD MET FLM 1.00 MEGOHM 1% 1/4W	28480	0757-0344
A2R7	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R8	0757-0367		R:FXD MET FLM 100K OHM 1% 1/2W	28480	0757-0367
A2R9	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R10	0757-0407	6	R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A2R11	0761-0074	1	R:FXD MET OX 15K OHM 5% 1W	28480	0761-0074
A2R12	0757-0426	1	R:FXD FLM 1.3K OHM 1% 1/8W	28480	0757-0426
A2R13	0757-0447	1	R:FXD MET FLM 16.2K OHM 1% 1/8W	28480	0757-0447
A2R14	2100-2514	1	R:VAR CERMET 20K OHM 10% LIN 1/2W	28480	2100-2514
A2R15	0698-3153	1	R:FXD MET FLM 3.83K OHM 1% 1/8W	28480	0698-3153
A2R16	0757-0463	1	R:FXD MET FLM 82.5K OHM 1% 1/8W	28480	0757-0463
A2R17	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R18	0757-0792	1	R:FXD MET FLM 681K OHM 1% 1/4W	28480	0757-0792
A2R19	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A2R20	0757-0460	4	R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A2R21	0757-0441	2	R:FXD MET FLM 8.25K OHM 1% 1/8W	28480	0757-0441
A2R22	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A2R23	0757-0764	1	R:FXD FLM 33.2K OHM 1% 1/4W	28480	0757-0764
A2R24	0757-0741	2	R:FXD MET FLM 2.43K OHM 1% 1/4W	28480	0757-0741
A2R25	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A2R26	0757-0443	2	R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A2R27	0757-0736	2	R:FXD MET FLM 1.50K OHM 1% 1/4W	28480	0757-0736
A2R28	0757-0413	2	R:FXD MET FLM 392 OHM 1% 1/8W	28480	0757-0413
A2R29	0757-0846	2	R:FXD MET FLM 22.1K OHM 1.0% 1/2W	28480	0757-0846
A2R30	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A2R31	0757-0284	1	R:FXD MET FLM 150 OHM 1% 1/8W	28480	0757-0284
A2R32	2100-1770	1	R:VAR WW 100 OHM 5% TYPE H 1W	28480	2100-1770
A2R33	0757-0411	1	R:FXD MET FLM 332 OHM 1% 1/8W	28480	0757-0411
A2R34	2100-1771	1	R:VAR WW 200 OHM 5% TYPE H 1W	28480	2100-1771
A2R35	0757-0428		R:FXD MET FLM 1.62K OHM 1% 1/8W	28480	0757-0428
A2R36	2100-1773		R:VAR WW 1K OHM 5% TYPE H 1W	28480	2100-1773
A2R37	0698-3416	4	R:FXD MET FLM 21.5K OHM 1% 1/2W	28480	0698-3416
A2R38	2100-0741	1	R:VAR WW 5K OHM 5% 1W	28480	2100-0741
A2R39	0698-3416		R:FXD MET FLM 21.5K OHM 1% 1/2W	28480	0698-3416
A2R40	0757-0434	3	R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A2R41	0757-0434		R:FXD MET FLM 3.65K OHM 1% 1/8W	28480	0757-0434
A2R42	0757-0448	1	R:FXD MET FLM 18.2K OHM 1% 1/8W	28480	0757-0448
A2R43	0757-0841	2	R:FXD MET FLM 12.1K OHM 1% 1/2W	28480	0757-0841
A2R44	0757-0841		R:FXD MET FLM 12.1K OHM 1% 1/2W	28480	0757-0841
A2R45	0757-0468	3	R:FXD FLM 130K OHM 1% 1/8W	28480	0757-0468
A2R46	0757-0440	1	R:FXD MET FLM 7.50K OHM 1% 1/8W	28480	0757-0440
A2R47	0757-0427	1	R:FXD MET FLM 1.5K OHM 1% 1/8W	28480	0757-0427
A2R48	0757-0741		R:FXD MET FLM 2.43K OHM 1% 1/4W	28480	0757-0741
A2R49	0757-0281		R:FXD MET FLM 2.74K OHM 1% 1/8W	28480	0757-0281
A2R50	0757-0200	1	R:FXD MET FLM 5.62K OHM 1% 1/8W	28480	0757-0200
A2R51	0757-0443		R:FXD MET FLM 11.0K OHM 1% 1/8W	28480	0757-0443
A2R52	0757-0736		R:FXD MET FLM 1.50K OHM 1% 1/4W	28480	0757-0736
A2R53	0757-0846		R:FXD MET FLM 22.1K OHM 1.0% 1/2W	28480	0757-0846
A2R54	0757-0413		R:FXD MET FLM 392K OHM 1% 1/8W	28480	0757-0413
A2R55	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A2R56	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2R57	2100-2030	1	R:VAR FLM 20K OHM 10% LIN 1/2W	28480	2100-2030
A2R58	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A2S1	3101-0982	1	SWITCH:SLIDE SPST 0.5A 125V	79727	GF124-0007
A3	00180-66552	1	BOARD ASSY:GATE	28480	00180-66552
A3C1	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C2	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C3	0121-0429		C:VAR POLY 0.7-3.0 PF 600VDCW	72982	536-009
A3C4	0150-0048		C:FXD 0.22 PF 500 VDCW	28480	0150-0048
A3C5	0121-0168		C:VAR TEFLON 0.25-1.50 PF 600VDCW	28480	0121-0168
A3C6	0160-3451	1	C:FXD CER 0.01 UF+80-20% 100VDCW	56289	CO23B101F103ZS25-CD
A3C7	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C8	0160-0303	1	C:FXD MYLAR .15 UF 10% 200VDCW	28480	0160-0303
A3C10	0180-0089		C:FXD AL ELECT 10UF +50-10% 150VDCW	56289	30D106F150 DD2-DSM
A3C11	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C12	0180-0155	3	C:FXD ELECT 2.2 UF 20% 20VDCW	56289	150D225X0020A2-DYS
A3C13	0160-0162		C:FXD MY 0.022 UF 10% 200VDCW	56289	192P22392-PTS
A3C14	0160-2961	2	C:FXD MICA 5825 PF 2% 300VDCW	04062	RDM20F(5825)G3C
A3C15	0160-2961		C:FXD MICA 5825 PF 2% 300VDCW	04062	RDM20F(5825)G3C
A3C16	0180-0089		C:FXD AL ELECT 10 UF +50-10% 150VDCW	56289	30D106F150DD2-DSM
A3C17	0180-0076	1	C:FXD ELECT 20UF 25VDCW	56289	40D206G025DC6M1
A3C18	0170-0019	1	C:FXD MY 0.1 UF 5% 200VDCW	28480	0170-0019
A3C19	0160-3008	3	C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C20	0160-3007	4	C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C21	0160-3008		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C22	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C23	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C24	0160-3008		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3C25	0160-3007		C:FXD CER 4700 PF 20% 4K VDCW	72982	3888-024-Y5SO-472M
A3C26	0160-2261		C:FXD CER 15 PF 5% 500 VDCW	72982	301-NPO-15PF
A3C27	0150-0093		C:FXD CER 0.01UF +80-20% 100VDCW	72982	801-K800011
A3C28	0160-2198		C:FXD MICA 20PF 5%	72136	RDM15-C200J3C
A3CR1	1901-0179	1	DIODE:DILICON 15WV	28480	1901-0179
A3CR2 THRU A3CR5	1901-0535		DIODE:DI 15V	28480	1901-0535
A3CR6	1901-0029	2	DIODE:SILICON 600 PIV	28480	1901-0029
A3CR7	1901-0029		DIODE:SILICON 600 PIV	28480	1901-0029
A3CR8	1901-0436	2	DIODE:SILICON 1600 PIV	28480	1901-0436
A3CR9	1901-0436		DIODE:SILICON 1600 PIV	28480	1901-0436
A3CR11	1901-0096	3	DIODE:SILICON 120V	01295	UG-888
A3CR12	1901-0096		DIODE:SILICON 120V	01295	UG-888
A3CR13	1901-0096		DIODE:SILICON 120V	01295	UG-888
A3E1	0360-1514		PIN: SQUARE	28480	0360-1514
A3L1	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A3L2	9140-0179		COIL/CHOKE 22.0 UH 10%	28480	9140-0179
A3MP1	1205-0063		HEAT SINK:SEMICONDUCTOR	05820	224-CB
A3Q1	1854-0092		TSTR: SI NPN	80131	2N3563
A3Q2	1854-0019		TSTR:SI NPN	28480	1854-0019
A3Q3	1853-0038		TSTR:SI PNP	28480	1853-0038
A3Q4	1854-0271	1	TSTR:SI NPN	28480	1854-0271
A3Q6	1854-0234	2	TSTR:SI NPN	80131	2N3440
A3Q7	1854-0234		TSTR:SI NPN	80131	2N3440
A3Q8	1854-0023	1	TSTR:SI NPN	28480	1854-0023
A3Q9	1854-0071		TSTR:SI NPN	28480	1854-0071
A3Q10	1854-0039		TSTR:SI NPN	80131	2N3053
A3Q11	1854-0092		TSTR:SI NPN	80131	2N3563
A3Q12	1853-0049		TSTR:SI PNP	28480	1853-0049
A3Q13	1853-0049		TSTR:SI PNP	28480	1853-0049
A3Q14	1854-0215		TSTR:SI NPN	80131	2N3904
A3R1	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A3R2	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A3R3	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R4	0757-0458		R:FXD MET FLM 51.1K OHM 1% 1/8W	28480	0757-0458
A3R5	0757-0435		R:FXD MET FLM 3.92K OHM 1% 1/8W	28480	0757-0435
A3R6	0757-0419		R:FXD FLM 681 OHM 1% 1/8W	28480	0757-0419
A3R7	0757-0290	1	R:FXD MET FLM 6.19K OHM 1% 1/8W	28480	0757-0290
A3R8	0757-0724	1	R:FXD FLM 392 OHM 1% 1/4W	28480	0757-0724
A3R9	0757-0727	1	R:FXD MET FLM 562 OHM 1% 1/4W	28480	0757-0727
A3R11	0698-3421		R:FXD MET FLM 38.3K OHM 1% 1/2W	28480	0698-3421
A3R13	0757-0833		R:FXD MET FLM 5.11K OHM 1% 1/2W	28480	0757-0833
A3R14	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R15	0757-0190	3	R:FXD MET FLM 20K OHM 1% 1/2W	28480	0757-0190
A3R16	0757-0416	1	R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A3R17	0687-1011	1	R:FXD COMP 100 OHM 10 % 1/2W	01121	EB 1011
A3R18	0761-0083	1	R:FXD MET OX 68K OHM 5% 1W	28480	0761-0083
A3R24	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R25	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R26	0683-0275		R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A3R27	0757-0401		R:FXD MET FLM 100 OHM 1% 1/8W	28480	0757-0401
A3R28	0757-0190		R:FXD MET FLM 20K OHM 1% 1/2W	28480	0757-0190
A3R29	0757-0468		R:FXD FLM 130K OHM 1% 1/8W	28480	0757-0468
A3R30	0757-0468		R:FXD FLM 130K OHM 1% 1/8W	28480	0757-0468
A3R31	0757-0283		R:FXD MET FLM 2.00K OHM 1 % 1/8W	28480	0757-0283
A3R32	0757-0407		R:FXD MET FLM 200 OHM 1% 1/8W	28480	0757-0407
A3R33	0757-0190		R:FXD MET FLM 20K OHM 1% 1/2W	28480	0757-0190
A3R34	0698-5421	1	R:FXD MET FLM 17.82K OHM 0.1% 1/2W	28480	0698-5421
A3R35	0698-5418	1	R:FXD FLM 50 OHM 0.1% 1/8W	28480	0698-5418
A3R36	0698-5419	1	R:FXD FLM 1.95K OHM 0.1% 1/8W	28480	0698-5419
A3R37	0683-0275		R:FXD COMP 2.7 OHM 5% 1/4W	01121	CB 27G5
A3R38	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A3R39	0757-0814	1	R:FXD MET FLM 511 OHM 1% 1/2W	28480	0757-0814
A3R40	0757-0284		R:FXD MET FLM 150 OHM 1% 1/8W	28480	0757-0284
A3R41	0757-0465		R:FXD MET FLM 100K OHM 1% 1/8W	28480	0757-0465
A3R42	0757-0283		R:FXD MET FLM 2.00K OHM 1% 1/8W	28480	0757-0283
A3R43	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R44	0757-0442	2	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R45	0757-0438		R:FXD MET FLM 5.11K OHM 1% 1/8W	28480	0757-0438
A3R46	0698-3553	1	R:FXD FLM 2.49 MEGOHM 1% 1/2W	28480	0698-3553
A3R47	0757-0442	1	R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R48	0757-0870	1	R:FXD MET FLM 825K OHM 1% 1/2W	28480	0757-0870
A3R49	2100-0944	1	R:VAR COMP 200 K OHM 20% 3/4W	75042	CT150
A3R50	0687-5611	1	R:FXD COMP 560 OHM 10 % 1/2W	01121	EB 5611
A3R51	0698-7182	1	R:FXD MET FLM 30 MEGOHM 1% 2W	28480	0698-7182
A3R52	0683-1055	1	R:FXD COMP 1 MEGOHM 5% 1/4W	01121	CB 1055
A3R53	0757-0460		R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A3R54	0757-0456	3	R:FXD MET FLM 43.2K OHM 1% 1/8W	28480	0757-0456
A3R55	0757-0456		R:FXD MET FLM 43.2K OHM 1% 1/8W	28480	0757-0456
A3R56	0757-0460		R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460
A3R57	0683-5125	1	R:FXD COMP 5100 OHM 5% 1/4W	01121	CB 5125
A3R58	0698-5677	1	R:FXD FLM 8.25 MEGOHM 5% 1W	28480	0698-5677
A3R59	0698-5678	1	R:FXD FLM 16.25 MEGOHM 5% 1W	28480	0698-5678
A3R60	2100-2031	1	R:VAR 50K OHM 10 % LIN 1/2W	28480	2100-2031
A3R61	0757-0454	1	R:FXD MET FLM 33.2K OHM 1% 1/8W	28480	0757-0454
A3R62	0757-0280	1	R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R63	0757-0280		R:FXD MET FLM 1K OHM 1% 1/8W	28480	0757-0280
A3R64	0757-0460		R:FXD MET FLM 61.9K OHM 1% 1/8W	28480	0757-0460

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
A3R65	0757-0456		R:FXD MET FLM 43.2K OHM 1% 1/8W	28480	0757-0456
A3R66	0757-0436		R:FXD MET FLM 4320 OHM 1% 1/8W	28480	0757-0436
A3R67	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R68	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A3R69	0757-0433		R:FXD MET FLM 3320 OHM 1% 1/8W	28480	0757-0433
A3R70	0757-0442		R:FXD MET FLM 10.0K OHM 1% 1/8W	28480	0757-0442
A3R71	0757-0274		R:FXD MET FLM 1210 OHM 1 % 1/8W	28480	0757-0274
A3R72	0757-0465		R:FXD MET FLM 100 K OHM 1% 1/8W	28480	0757-0465
A3R73	0757-0419		R:FXD MET FLM 681 OHM 1 % 1/8W	28480	0757-0419
A3R74	0757-0416		R:FXD MET FLM 511 OHM 1% 1/8W	28480	0757-0416
A3R75	0757-0438		R:FXD MET FLM 5110 OHM 1% 1/8W	28480	0757-0438
A3R76	0757-0280		R:FXD MET FLM 1.0K OHM 1% 1/8W	28480	0757-0280
A4	00180-66550	1	BOARD ASSY:HIGH VOLTAGE OSCILLATOR	28480	00180-66550
A4C1	0180-0097	1	C:FXD TANT. 47 UF 10% 35VDCW	56289	150D476X9035S2-DYS
A4C2	0160-0380	1	C:FXD MY 0.22 UF 10 % 200VDCW	28480	0160-0380
A4CR1	1901-0049		DIODE:SILICON 50PIV	28480	1901-0049
A4CR2	1901-0040		DIODE:SILICON 30MA 30WV	07263	FDG1088
A4E1	0360-1514		PIN:SQUARE	28480	0360-1514
A4E2	2110-0269		CLIP:FUSE 0.250" DIA	91506	6008-32CN
A4L1	9140-0071	1	COIL:FXD RF: 22UHY	28480	9140-0071
A4R1	0757-0900		R:FXD MET FLM 100 OHM 2% 1/8W	28480	0757-0900
A4XQ1	1251-3027	1	CONNECTOR:F & P 3 FEMALE CONTACT	27264	09-52-3032
A5	00180-66544	1	BOARD ASSY:HIGH VOLTAGE RECTIFIER	28480	00180-66544
A5C1	0160-0907	1	C:FXD CER 0.01 UF +80-20% 500VDCW	14655	TM50R23Z-1
A5C2	0160-2320	1	C:FXD CER 0.01 UF 5000VDCW	28480	0160-2320
A5CR1	1901-0341	2	DIODE:SI 7000 PIV 50MA	28480	1901-0341
A5CR2	1901-0341		DIODE:SI 7000 PIV 50MA	28480	1901-0341
A5H1	5040-0402	1	MOUNT:TRANSFORMER	28480	5040-0402
A5H2	5040-0430	1	MOUNT:TRANSFORMER	28480	5040-0430
A5H3	0340-0039	2	INSULATOR:BUSHING	28480	0340-0039
A5R1	0683-2235	1	R:FXD COMP 22K OHM 5% 1/4W	01121	CB 2235
A5R2	2100-0918	1	R:VAR COMP 1 MEGOHM 20% LIN 1/5W	28480	2100-0918
A5R3	0836-0003	1	R:FXD FLM 29 MEGOHM 10 % 1W	28480	0836-0003
A5T1	00180-60801	1	TRANSFORMER ASSY:HV	28480	00180-60801
A6	00180-61105	2	H.V. MULTIPLIER ASSY(CAB) (NOT FIELD REPAIRABLE)	28480	00180-61105
	00180-61106	1	H.V. MULTIPLIER ASSY(RACK) (NOT FIELD REPAIRABLE)	28480	00180-61106
A7	00180-66551	1	BOARD ASSY: AUXILLIARY OUTPUT	28480	00180-66551
A7C1	0160-3446	1	C: FXD CER 220 PF 10% 1000 VDCW	28480	0160-3446
A7R1	0757-0438	3	R: FXD MET FLM 5110 OHM 1% 1/8W	28480	0757-0438
A7R2	0757-0438		R: FXD MET FLM 5110 OHM 1% 1/8W	28480	0757-0438
A7R3	0757-0438		R: FXD MET FLM 5110 OHM 1% 1/8W	28480	0757-0438
A1	00184-60003		POWER MODULE: LOW VOLTAGE	28480	00184-60003
A1A1	00184-66511		ASSY:LOW VOLTAGE RECTIFIER BOARD	28480	00184-66511
A1A2	00184-66509		ASSY:LOW VOLTAGE REGULATOR BOARD	28480	00184-66509
A2	00180-66543		BOARD ASSY:HORIZONTAL AMPLIFIER	28480	00180-66543
A3	00180-66552		BOARD ASSY:GATE	28480	00180-66552
A4	00180-66550		BOARD ASSY: HIGH VOLTAGE OSCILLATOR	28480	00180-66550
A5	00180-66544		BOARD ASSY: HIGH VOLTAGE RECITIFIER	28480	00180-66544
A6	00180-61105		H.V. MULTIPLIER ASSY(CAB)	28480	00180-61105
	00180-61106		H.V. MULTIPLIER ASSY (RACK)	28480	00180-61106
A7	00180-66546		BOARD ASSY: SWEEP GATE	28480	00180-66546
A8	00180-61904		SWITCH ASSY: DISPLAY	28480	00180-61904
C1	0170-0022	1	C:FXD MY 0.1 UF 20% 600VDCW	01934	TYPE 24
C2	0160-3484	2	C:FXD CER FEED-THRU 1000 PF 20% 1000V	72982	2432-009 X5U 102M
C3	0160-3484		C:FXD CER FEED-THRU 1000 PF 20% 1000V	72982	2432-009 X5U 102M
DS1	2140-0346	1	LAMP:INCANDESCENT 5V	71744	7210
E1	0340-0450	1	WASHER: TRANSISTOR INSULATOR	04713	14B52600F12
E2	0340-0451	1	WASHER: INSULATED, TRANSISTOR	04713	14B52600F03
E3	0362-0227	68	TERMINATION: CRIMP LUG FOR 26 AWG	27264	0362-0227
E4	1251-2039	9	CONNECTOR: CRT NECK PIN	28480-	1251-2039
E5	0362-0277	2	TERMINATION: CRIMP LUG (CRT FIL LEADS)	59730	A18-187
E6	0362-0265		TERMINATION: CRIMP LUG	27264	1923
F1	2110-0020	1	FUSE:0.8 A 250V SLOW-BLOW (230V OPERATION)	75915	313.800S
	2110-0005	1	FUSE:CARTRIDGE 1.6 AMP 125V (115V OPERATION)	71400	MDL 1.6
F2	2110-0033	1	FUSE: 0.75A 250V	75915	F02GR750A

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
J1	1251-0137	1	CONNECTOR: PC 32 CONTACT PART OF W6	02660	26-4200-32S
J2	1251-0172	1	CONNECTOR: PC EDGE 1 ROW 22 CONTACT PART OF W6	71785	250-22-30-210
J3			NSR, PART OF MP42, MP80.		
J4			NSR, PART OF MP42, MP80.		
J5	1510-0038	2	BINDING POST	28480	1510-0038
J6	1250-0083	6	CONNECTOR: BNC	02660	31-221-1020
J7	1250-0083		CONNECTOR: BNC	02660	31-221-1020
J8	1250-0083		CONNECTOR: BNC	02660	31-221-1020
J9	1250-0083		CONNECTOR: BNC	02660	31-221-1020
J10	1250-0083		CONNECTOR: BNC	02660	31-221-1020
J11	1250-0083		CONNECTOR: BNC	02660	31-221-1020
J12	1251-2357	1	SOCKER: 3 PIN MALE POWER RECEPTACLE	82389	EAC-301
J13	1510-0038		BINDING POST	28480	1510-0038
J14	0363-0006	2	CONTACT: CONNECTOR SWITCH	28480	0363-0006
L1	00180-65601	1	COIL ASSY: Y ALIGNMENT	28480	00180-65601
L2	5060-0435	1	COIL: ALIGNMENT Z AXIS	28480	5060-0435
L3	9170-0013	1	COIL: CORE, TOROID, GREEN	72656	CF-102-H
MP1	5060-0548	1	KIT: CONTRAST FILTER; BLUE	28480	5060-0548
MP2	5040-0444	1	SHIELD: LIGHT BLACK NYLON	28480	5040-0444
MP3	5020-0476	1	BEZEL: CRT	28480	5020-0476
MP4	00180-04130	1	COVER: BTM RIGHT	28480	00180-04130
MP5	00180-04132	1	COVER: BTM LEFT	28480	00180-04132
MP6	00180-04134	1	COVER: TOP RIGHT	28480	00180-04134
MP7	00180-04136	1	COVER: TOP LEFT	28480	00180-04136
MP8	0370-0432	1	KNOB: BLACK LEVER	28480	00180-0432
MP9	00180-05002	1	LEVER: HORIZONTAL POSITION	28480	00180-05002
MP10	00180-67402	2	KNOB: HORIZONTAL POSITION	28480	00180-67402
MP11	00180-67404	2	KNOB ASSY: BAR WITH BLACK ARROW	28480	00180-67404
MP12	00180-67404		KNOB ASSY: BAR WITH BLACK ARROW	28480	00180-67404
MP13	00180-67405	1	KNOB:RND BLK (FIND BEAM)	28480	00180-67405
MP14	0370-0348	1	KNOB: RND BLK 0.540" DIA	28480	0370-0348
MP15	00180-67403	1	KNOB ASSY	28480	00180-67403
MP16	00180-67402		KNOB: HORIZONTAL POSITION	28480	00180-67402
MP17	0403-0128	1	GUIDE: PC BD PLUG-IN (LEFT)	28480	0403-0128
MP18	0403-0129	1	GUIDE: PC BD PLUG-IN (RIGHT)	28480	0403-0129
MP19	0510-0705	2	PIN:SPRING 0.094" DIA	00287	OBD#
MP20	0510-0952	2	RING:RETAINING STL FOR 0.094" DIA SHAFT	79136	X5133-9-S-MD
MP21	1460-0706	2	SPRING: COMPRESSION	00000	OBD
MP22	3050-0441	2	WASHER: SHOULDER .125 ID FOR #4 HDW	28480	3050-0441
MP23	5020-0499	2	HINGE: PROBE HANGER	28480	5020-0449
MP24	5040-0463	2	HANGER: PROBE	28480	5040-0463
MP25	5040-0464	2	HANGER: PROBE	28480	5040-0464
MP26	5040-0459	1	HANDLE	28480	5040-0459
MP27	00180-24718	2	SPACER: HANDLE	28480	00180-24718
MP28	00180-22301	2	KEEPER: HANDLE	28480	00180-22301
MP29	00180-09103	2	SPRING: INSERT	28480	00180-09103
MP30	00180-07201	2	INSERT: KEEPER	28480	00180-07201
MP31	4320-0231	1	RUBBER: RFI	00000	OBD#
MP32	00180-60118	1	CHASSIS: CAB POWER	28480	00180-60118
MP33	00180-60117	1	CHASSIS: CAB DISPLAY	28480	00180-60117
MP34	00180-24728	1	SPACER:FRONT	28480	00180-24728
MP35	00180-24727	1	SPACER:REAR	28480	00180-24727
MP36	00180-24726	2	SPACER:SIDE	28480	00180-24726
MP37	7120-1254	1	TRADEMARK	28480	7120-1254
MP38	5040-0445	2	FOOT: BOTTOM	28480	5040-0445
MP39	5040-0446	2	FOOT: REAR, SHORT,	28480	5040-0446
MP40	5040-0447	2	FOOT: REAR (LONG)	28480	5040-0447
MP41	00180-00602	1	SHIELD: CRT	28480	00180-00602
MP42	00180-00245	1	PANEL: FRONT (CAB)	28480	00180-00245
MP43	00180-0047	1	PANEL: FRONT, SUB	28480	00180-00247
MP44	0400-0010	2	GROMMET: VINYL 0.250" ID	00000	OBD#
MP45	1400-0026	1	CLAMP: HOSE	66295	36H
MP46	00180-41207	2	BRACKET: PLASTIC	28480	00180-41207
MP47	00180-09104	2	CLIP: GROUND	28480	00180-09104
MP48	00180-23701	1	SHAFT: BEAM FINDER	28480	00180-23701
MP49	00180-01253	1	BRACKET: BEAM FIND	28480	00180-01253
MP50	5040-0453	1	COVER: POTENTIOMETER (FOCUS)	28480	5040-0453
MP51	00180-01209	1	BRACKET: CONNECTOR PLUG-IN	28480	00180-01209
MP52	00180-01218	2	BRACKET: ALIGNMENT COIL	28480	00180-01218
MP53	00180-04128	1	COVER: HV PLATE	28480	00180-04128
MP54	00180-25402	1	PLEXIGLASS	28480	00180-25402
MP55	00180-24301	1	NUT: HORIZONTAL POSITION P07	28480	00180-61685
MP56	1400-0325	2	CLAMP: CABLE 0.125" DIA	00000	OBD
MP57	00180-44701	1	SPACE: TRADEMARK	28480	00180-44701
MP58	00180-24702	1	STANDOFF: GATE INSULATING	28480	00180-24702
MP59	0570-0031	1	SCREW: RND HD SLOT DR 4-40 INSULATING	00000	OBD
MP60	0400-0010		GROMMET: VINLY 0.250" ID	00000	OBD#
MP61	2200-0762	20	SCREW: TRUSS HD POZI DR 4-40 X 0.250" LG	00000	OBD
MP62	2200-0140	22	SCREW: FLAT HD POZI DR 4-40 X 0.250" LG	00000	OBD
MP63	2360-0192	12	SCREW: FLAT HD POZI DR 6-32 X 0.250" LG	00000	OBD
MP64	0590-0043	2	NUT: HEX 1/4 X 32 INTERNAL THREAD	00866	OBD
MP65	1490-0968	2	BUSHING: POTENTOIMETER 1/4-32 EXT THRD	00000	OBD

See introduction to this section for ordering information

Table 6-2. Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	Qty	Description	Mfr Code	Mfr Part Number
MP66	00180-04138	1	COVER: TOP (RACK)	28480	00180-04138
MP67	00180-04137	2	COVER: SIDE(RACK)	28480	00180-04137
MP68	00180-01217	2	BRACKET: COVER	28480	00180-01217
MP69	5060-0431	2	FRAME ASSY: SIDE	28480	5060-0431
MP70	5000-0051	2	TRIM STRIP	28480	5000-0051
MP71	00180-00601	1	SHIELD: POST ACCELERATOR	28480	00180-00601
MP72	00180-60119	1	CHASSIS ASSY: DISPLAY (RACK	28480	00180-60119
MP73	00180-60120	1	CHASSIS ASSY: POWER (RACK)	28480	00180-60120
MP74	5000-0449	1	SPACER: FRONT	28480	5000-0449
MP75	5000-0469	1	SPACER: REAR	28480	5000-0469
MP76	00180-64110	1	COVER ASSY: BOTTOM	28480	00180-64110
MP77	1490-0030	1	STAND: TILT	28480	1490-0030
MP78	5060-0767	5	FOOT ASSY: FM	28480	5060-0767
MP79	5060-0552	1	KIT: 5 H RACK MOUNT	28480	5060-0552
MP80	00180-00246	1	PANEL: FRONT (RACK)	28480	00180-00246
MP81	00180-01255	1	BRACKET: BRACE	28480	00180-01255
MP82	00180-01246	1	BRACKET: GROUND LINE FILTER	28480	00180-01246
MP83	00182-01209	1	BRACKET: LINE FILTER	28480	00182-01209
MP84	00182-00601	1	SHIELD: LINE FILTER	28480	00182-00601
MP85	1450-0404	1	LENS: CLEAR	28480	1450-0404
MP86	00180-01249	1	BRACKET: VERTICAL LEADS	28480	00180-01249
MP87	00180-01251	1	BRACKET: TRANSISTOR	28480	00180-01251
MP88	00180-41208	1	CLIP: HORIZONTAL	28480	00180-41208
MP89	00180-01250	1	BRACKET: VERTICAL LEADS	28480	00180-01250
MP90	1490-0710	1	STAND: TILT (CAB)	28480	1490-0710
MP91	00180-09105	1	CLIP-GROUND	28480	00180-09105
MP92	1400-0090	1	WASHER:RUBBER 5/8" OD	00000	OBD
MP93	00180-60204	1	PANEL: REAR	28480	00180-60204
MP111	00182-00206	1	PANEL: ACCESS	28480	00182-00206
Q1	1854-0609	1	TSTR: SI NPN	28480	1854-0609
R1	2100-3287	1	R: VAR COMP 2X 100 K OHM 20% LIN	28480	2100-3287
R2	2100-1904	1	R: VAR COMP 10K OHM 20% LIN 1/4W	28480	2100-1904
R3	2100-3147	1	R: VAR COMP 5 MEGOHM 20% LIN	28480	2100-3147
R4	0683-1045	1	R:FXD COMP 100K OHMS 5% 1/4W	01121	CB 1045
R5	2100-1905	1	R;VAR COMP 50K OHM 20% LIN 1/2W	28480	2100-1905
R6	2100-1903	1	R: VAR WW 5K OHM 10% LIN 2W	28480	2100-1903
R7	2100-1901	1	R: VAR WW 100 OHM 10% LIN 2W	28480	2100-1901
S1	3101-1508	1	SWITCH: TOGGLE DPDT	09353	73181
S2	3101-0070	1	SWITCH: SLIDE	79727	G-126
S3	3100-1345	1	SWITCH: ROTARY 1 SECTION 3 POSITION	28480	3100-1345
S4	3101-0977	1	SWITCH: PUSHBUTTON DPDT	82389	12S-1032
S5	3101-1237	1	SWITCH: SLIDE DPDT	82389	11A-1243
V1	5083-3552	1	CRT: P31 ALUMINIZED INT GRAT	28480	5083-3552
W1	8120-1538	1	CABLE ASSY: POWER 7.5 FT. (CAB)	28480	8120-1538
	8120-1545	1	CABLE ASSY: AC POWER CORD 7.5 FT (RACK)	70903	KH 7171
W2	00180-61616	1	CABLE ASSY:	28480	00180-61616
	00180-61617	1	CABLE ASSY:	28480	00180-61617
W3	00180-61685	1	CABLE: CRT TWIN LEAD: VERTICAL	28480	00180-61685
W4	00180-61807	1	CABLE ASSY: AUXILIARY OUTPUT	28480	00180-61807
W5	00180-61651	1	CABLE ASSY: HORIZONTAL (CAB)	28480	00180-61651
	00180-61656	1	CABLE ASSY: HORIZONTAL (RACK)	28480	00180-61656
W6	00180-61694	1	CABLE ASSY: MAIN (CAB)	28480	00180-61694
	00180-61695	1	CABLE: MAIN (RACK)	28480	00180-61695
W7	00180-61657	1	CABLE ASSY: HORIZONTAL MAGNIFIER	28480	00180-61657
W8	00180-61696	1	CABLE ASSY: 4-COND (RACK) (S4 TO J2)	28480	00180-61696
	00180-61697	1	CABLE ASSY: 4-COND (CAB) (S4-TO J2)	28480	00180-61697
			PART OF W6		
W9	00180-61698	1	CABLE ASSY: 4-COND (RACK) (INCLUDES L3)	28480	00180-61698
	00180-61699	1	CABLE ASSY: 4-COND (CAB) (INCLUDES L3)	28480	00180-61699
			PART OF W6		
W10	00180-61609	1	CABLE: COAX, (EXT INPUT)	28480	00180-61609
			PART OF W6		
W11	00180-61646	1	CABLE: COAX, BLUE	28480	00180-61646
W12	00180-61647	1	CABLE: COAX, WHITE	28480	00180-61647
W13	00180-61648	1	CABLE: COAX, YELLOW	28480	00180-61648
W14	00180-61649	1	CABLE: COAX, RED	28480	00180-61649
W15	00180-61801	1	CABLE: COAX, YELLOW	28480	00180-61801
			PART OF W6		
W16			NOT USED		
W17	00180-61642	1	CABLE: COAX: RED-ST (ALT TRIGGER) (CAB)	28480	00180-61642
	00180-61638	1	CABLE: COAX, RED-ST (ALT TRIGGER) RACK)	28480	00180-61638
			PART OF W6		
W18	00180-61640	1	CABLE: COAX, BLUE-ST (UNBLANK GATE)(RACK)	28480	00180-61640
	00180-61644	1	CABLE: COAX. BLUE-ST (UNBLANK GATE)(CAB)	28480	00180-61644
W19	00180-61643	1	CABLE: COAX, BLACK-ST (CHOP BLANK)(CAB)	28480	00180-61643
			PART OF W6		
	00180-61641	1	CABLE: COAX, BLACK-ST (CHOP BLANK)(RACK)	28480	00180-61641
W20	00180-61645	1	CABLE: SHIELDED (CALIBRATOR)	28480	00180-61645
			PART OF W6		
W21	00180-61652		CABLE: COAX, DISPLAY SWITCH	28480	00180-61652
XDS1	00183-67701	1	BASE: PILOT LIGHT	28480	00183-67701
XF1	1400-0084	1	FUSEHOLDER: EXTRACTOR POST TYPE	75915	342014
XV1			PART OF W6. CONSISTS OF:		
	1200-0037	1	SOCKET: CRT TUBE	72825	97097
	1200-0050	7	CONTACT: CRT SOCKET	72825	9553-1
	1200-0408	1	COVER: CRT SOCKET	28480	1200-0408

See introduction to this section for ordering information

Table 6-3. List of Manufacturers' Codes

MFR NO.	MANUFACTURER NAME	ADDRESS	ZIP CODE
00000	U.S.A. COMMON	ANY SUPPLIER OF U.S.A.	
00287	CEMCO	DANIELSON, CONN.	06239
00853	SANGAMO ELECTRIC CO.PICKENS DIV.	PICKENS, S.C.	29671
00866	GOE ENGINEERING CO. INC.	CITY OF INDUSTRY, CALIF.	91746
01121	ALLEN BRADLEY CO.	MILWAUKEE, WIS.	53204
01295	TEXAS INSTRUMENTS INC. SEMICONDUCTOR COMPONENTS DIV.	DALLAS, TEX.	75231
02114	FERROXCUBE CORP.	SAUGERTIES, N.Y.	12477
02660	AMPHENOL CORP.	BROADVIEW, ILL.	60153
04062	ARCO ELECTRONIC INC.	GREAT NECK, N. Y.	08718
04713	MOTOROLA SEMICONDUCTOR PROD.INC.	PHOENIX, ARIZ.	85008
05820	WAKEFIELD ENGINEERING INC.	WAKEFIELD, MASS.	01880
07263	FAIRCHILD CAMERA & INST. CORP. SEMICONDUCTOR DIV.	MOUNTAIN VIEW, CALIF.	94040
08806	G.E. CO. MINIATURE LAMP DEPT.	CLEVELAND, OHIO	44112
09134	TEXAS CAPACITOR CO. INC.	HOUSTON, TEX.	77042
09353	C & K COMPONENTS INC.	NEWTON, MASS.	02158
14655	CORNELL DUBLIER ELECT. DIV.FEDERAL PACIFIC ELECT. CO.	NEWARK, N.J.	07105
27264	MOLEX PROD. CO.	DOWNERS GROVE, ILL.	60515
28480	HEWLETT-PACKARD COMPANY	PALO ALTO, CALIF.	94304
56289	SPRAGUE ELECTRIC CO.	N. ADAMS, MASS.	01247
59730	THOMAS & BETTS CO. THE	ELIZABETH, N.J.	07207
66295	WITTEK MFG. CO.	CHICAGO, ILL.	60623
70903	BELDEN CORP.	CHICAGO, ILL.	60644
71400	BUSSMANN MFG. DIV. MC GRAW-EDISON CO.	ST. LOUIS, MO.	63017
71744	CHICAGO MINIATURE LAMP WORKS	CHICAGO, ILL.	60640
71785	CINCH MFG. CO. DIV TRW INC.	ELK GROVE VILLAGE, ILL.	
72136	ELECTRO MOTIVE MFG. CO. INC.	WILLIMANTIC, CONN.	06226
72656	INDIANA GENERAL CORP. ELECTRONIC DIV.	KEASBEY, N.J.	08832
72825	EBY HUGH H. INC.	PHILADELPHIA, PA.	19144
72982	ERIE TECHNOLOGICAL PROD. INC.	ERIE, PA.	16512
75042	INTERNATIONAL RESISTANCE CO. INC.	PHILADELPHIA, PA.	19108
75915	LITTELFUSE INC.	DES PLAINES, ILL.	60016
79136	WALDES KOHINOOR INC.	LONG IS. CITY, N.Y.	11101
79727	CONTINENTAL-WIRT ELECTRONICS CORP.	PHILADELPHIA, PA.	19144
80131	ELECTRONIC INDUSTRIES ASSOCIATION	WASHINGTON D.C.	20006
82389	SWITCHCRAFT INC.	CHICAGO, ILL.	60630
91506	AUGAT INC.	ATTLEBORO, MASS.	02703
95354	METHODE MFG. CO.	ROLLING MEADOWS, ILL.	60008
98291	SEALECTRO CORP.	MAMARONECK, N.Y.	10544

SECTION VII

MANUAL CHANGES AND OPTIONS

7-1. INTRODUCTION.

7-2. This section contains information required to backdate or update this manual for a specific instrument. Description of special options and standard options are also in this section.

7-3. MANUAL CHANGES.

7-4. This manual applies directly to the instrument having the same serial prefix shown on the manual title page. If the serial prefix of the instrument is not the same as the one on the title page, find your serial prefix in table 7-1 and make the changes to the manual that are listed for that serial prefix. When making changes listed in table 7-1, make the change with the highest number first. Example: if backdating changes 1, 2, and 3 are required for your serial prefix, do change 3 first, then change 2, and finally change 1. If the serial prefix of the instrument is not listed either in the title page or in table 7-1, refer to an enclosed MANUAL CHANGES sheet for updating information. Also, if a MANUAL CHANGES sheet is supplied, make all indicated ERRATA corrections.

Table 7-1. Manual Changes

Serial Prefix	Make Changes
No backdating changes are required at this time.	

7-5. SPECIAL OPTIONS.

7-6. Most customer special application requirements and/or specifications can be met by factory modification of a standard instrument. A standard instrument modified in this way will carry a special option number, such as Model 0000A/Option C01.

7-7. An operating and service manual and a manual insert are provided with each special option instrument. The operating and service manual contains information about the standard instrument. The manual insert for the special option describes the factory modifications required to produce the special option instrument. Amend the operating and service manual by changing it to include all manual insert information (and MANUAL CHANGES sheet information, if applicable). When these changes are made, the operating and service manual will apply to the special option instrument.

7-8. If you have ordered a special option instrument and the manual insert is missing, notify the nearest Hewlett-Packard Sales/Service Office. Be sure to give a full description of the instrument, including the complete serial number and special option number.

7-9. STANDARD OPTIONS.

7-10. Standard options are modifications installed on HP instruments at the factory and are available on request. Contact the nearest Hewlett-Packard Sales/Service Office for information concerning standard options.

SECTION VIII

SCHEMATICS AND TROUBLESHOOTING

8-1. INTRODUCTION.

8-2. This section contains schematics, repair and replacement information, component-identification illustrations, waveforms, test conditions and overall troubleshooting trees. A disassembly procedure for removing the CRT is also contained in this section.

8-3. SCHEMATICS.

8-4. Schematics are printed on fold-out pages for easy reference to the text and figures in other sections. The schematics are drawn to show the electronic function of the circuits. Any one schematic may include all or part of several different physical assemblies. Non MIL-standard symbols and conventions used in the schematics are defined in table 8-1.

8-5. The schematics are numbered in sequence with a bold number in the lower right-hand corner of each page. These numbers are used to cross reference signal connections between schematics. At each circuit breaking point a number in bold type indicates the associated schematic that contains the source or destination of the signal. To find the source or destination of any signal on a given schematic, turn to the schematic referred to by the bold-type number and find the function or the signal in question.

8-6. A reference designations table on each schematic lists all components shown on the schematic. Component reference designators which have been deleted from the schematic are listed below the table.

8-7. All components within the bordered areas of the schematic are physically located on etched circuit boards. Components not physically located on an etched circuit board are shown in the open areas of the schematic.

8-8. Transistors and diodes packaged in metal cans having one lead in common with the can will have the connection shown on the schematic by a heavy dot.

8-9. REFERENCE DESIGNATIONS.

8-10. The unit system of reference designations used in this manual is in accordance with the provisions of USA Standard Y32.16-1968, Reference Designations for Electrical and Electronics Parts and Equipments, dated March 1, 1968. Minor variations from the standard, due to design and manufacturing practices, may be noted.

8-11. Each electrical component is assigned a class letter and number. This letter-number combination is the basic reference designation. Components which are not part of an assembly have only the basic reference designation. Components which are part of an assembly have, in addition to the basic designation, a prefix designation indicating the assembly of which the component is a part (resistor R23 on assembly A1 is called A1R23).

8-12. Assemblies are numbered consecutively. If an assembly reference designation is assigned and later deleted, that number is not reused.

8-13. COMPONENT LOCATIONS.

8-14. Locations of components on assemblies and subassemblies are illustrated in figures adjacent to the schematics. Since the schematics are drawn to show function, portions of a particular assembly may appear on several different schematics. The component-location figure is printed next to the schematic that shows most of the circuitry on the assembly. The location of all adjustments are shown in Section V. An exploded-view drawing that shows mechanical (and some electrical) parts is located in Section VI.

8-15. BOARD CONNECTIONS. Square-pin connectors are identified on circuit boards by the color code of the connecting wire.

8-16. SEMICONDUCTOR REPLACEMENT. Figure 8-1 is included to help identify the leads of the common shapes and sizes of semiconductor devices. When removing a semiconductor, use long-nosed pliers as a heat sink between the device and the soldering iron. When replacing a semiconductor, ensure sufficient lead length to dissipate the soldering heat by using the same length of exposed lead as was used for the original part.

8-17. TROUBLESHOOTING.

WARNING

Read the Safety Summary at the front of this manual before troubleshooting the instrument.

8-18. Two important prerequisites for successful troubleshooting are understanding how the instrument

Table 8-1. Schematic Notes

REFER TO ANSI Y 32.2 AND Y32.14 FOR SCHEMATIC SYMBOLS NOT LISTED IN THIS TABLE.

ETCHED CIRCUIT BOARD

ASSEMBLY

ETCHED CIRCUIT BOARD ON ASSEMBLY

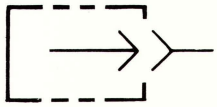
FRONT-PANEL MARKING

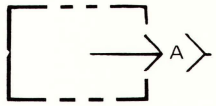
REAR-PANEL MARKING

MAIN SIGNAL PATH

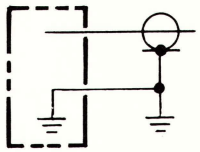
PRIMARY FEEDBACK PATH

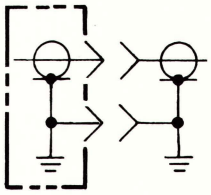
SECONDARY FEEDBACK PATH


SINGLE-PIN CONNECTOR ON BOARD



PIN OF A PLUG-IN BOARD (WITH LETTER OR NUMBER)


COAXIAL CABLE CONNECTED DIRECTLY TO BOARD


COAXIAL CABLE CONNECTED TO SNAP-ON JACK

FRONT-PANEL CONTROL

TEST POINT (TP WITH NUMBER)

SCREWDRIVER ADJUSTMENT

WAVEFORM TEST POINT (WITH NUMBER)

COMMON ELECTRICAL POINT (WITH LETTER); NOT NECESSARILY GROUND

SIGNAL REFERENCE

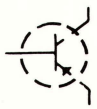
9 SCHEMATIC REFERENCE

BREAKDOWN DIODE (VOLTAGE REGULATOR)

LIGHT EMITTING DIODE (LED)

TUNNEL DIODE

FIELD-EFFECT TRANSISTOR (N-TYPE BASE)


CIRCUITS OR COMPONENTS DRAWN WITH DASHED LINES (PHANTOM) SHOW FUNCTION ONLY AND ARE NOT INTENDED TO BE COMPLETE. THE CIRCUIT OR COMPONENT IS SHOWN IN DETAIL ON ANOTHER SCHEMATIC.

(925) WIRE COLORS ARE GIVEN BY NUMBERS IN PARENTHESIS USING THE RESISTOR COLOR CODE

[(925) IS WHT-RED-GRN]

0 - BLACK	5 - GREEN
1 - BROWN	6 - BLUE
2 - RED	7 - VIOLET
3 - ORANGE	8 - GRAY
4 - YELLOW	9 - WHITE

* OPTIMUM VALUE SELECTED AT FACTORY, TYPICAL VALUE SHOWN; PART MAY HAVE BEEN OMITTED.

UNLESS OTHERWISE INDICATED: RESISTANCE IN OHMS, CAPACITANCE IN PICOFARADS AND INDUCTANCE IN MICROHENRIES

CW	CLOCKWISE END OF VARIABLE RESISTOR
NC	NO CONNECTION
P/O	PART OF

VF (A)

V - VOLTAGE
F - FILTERED
(A) - FILTER SOURCE

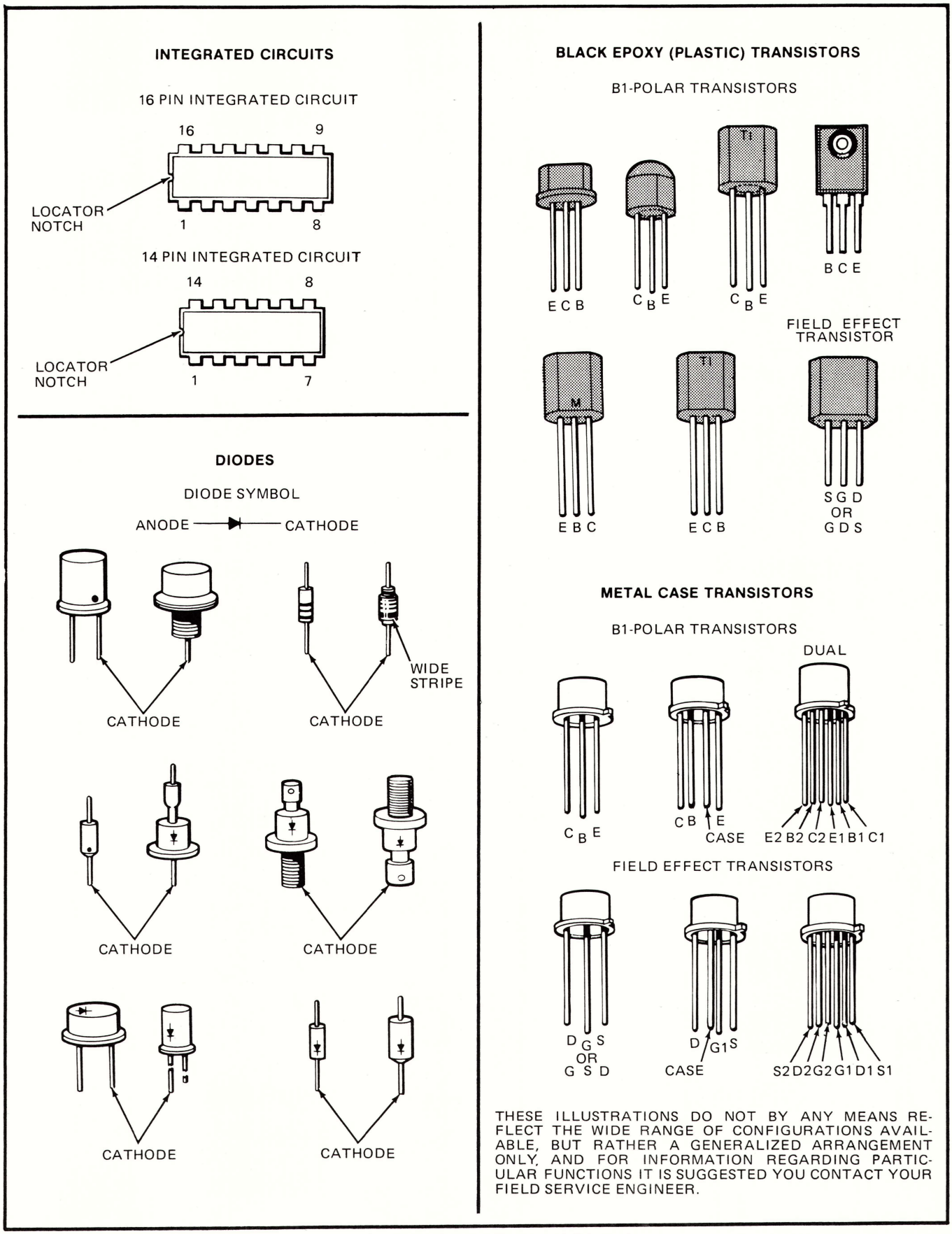


Figure 8-1. Semiconductor Terminal Identification

is designed to operate and correct use of front-panel controls. Suspected malfunctions may be caused by improper control settings or circuit connections. Before doing the test or troubleshooting procedures, read Section III (Operation) for an explanation of controls and general operating considerations, and Section IV (Principles of Operation) for an explanation of circuit theory.

8-19. If trouble is suspected, visually inspect the instrument. Look for loose or burned components that might suggest a source of trouble. Check to see that all circuit board connections are making good contact and are not shorting to an adjacent circuit. If no obvious trouble is found, check the power supply voltages in the unit. Prior to any extensive troubleshooting, check the external power sources also. Tables 8-2, 8-3, 8-4, 8-5 and 8-6 list several of the most common malfunctions and probable sources of trouble.

8-20. Dc voltages are indicated on the schematics for active components (transistors, etc). Conditions for making the voltage measurements are given in tables 8-7, 8-8, 8-9, and 8-10. Waveform measurement points (with a number enclosed) are placed on the schematics along main signal paths. The numbers inside the measurement point symbols are keyed to corresponding waveforms adjacent to each schematic.

8-21. REPAIR AND REPLACEMENT.

8-22. The following paragraphs provide procedures for replacing components in the instrument and basic considerations when repairing etched circuit boards. Section VI provides a parts list to allow ordering of replacement parts. If satisfactory repair cannot be obtained, contact the nearest HP Sales/Service Office (addresses at rear of this manual). If shipment of the instrument to the Sales/Service Office for repair is recommended, refer to Section II of this manual for repackaging and shipping information.

8-23. HIGH VOLTAGE SUPPLY REPAIR. The following procedures should be used when replacing the high voltage rectifier assembly (A5), and the high voltage multiplier assembly (A6).

CAUTION

To prevent CRT damage when troubleshooting the high voltage supply, disconnect the CRT socket and disconnect second anode connection (high voltage connector block). This will leave the capacitive load of the tripler on the high voltage transformer and maintain the normal 40-kHz oscillation.

a. Remove top left side cover of Model 180T or top cover and left side cover of 180TR (see figure 8-3).

b. Remove two screws from HVPS cover and lift up.

c. Remove four screws holding rear panel of display chassis and let panel hang.

d. Unsolder five wires from small printed circuit board mounted to A5T1.

e. Remove white, gray, red/blue, and red/white wires from printed circuit board A3 (HV control assembly).

NOTE

To remove A5 and A6 as a unit, omit steps f through h.

f. Remove four screws from HV rectifier assembly (A5).

g. Remove gray wire and yellow wire coming from HV multiplier assembly (A6).

h. A5 Assembly can now be removed by pulling out and toward front of instrument.

i. Unsolder wires on high voltage connector block mounted on chassis.

8-24. HEAT SINK REMOVAL. There are two types of heat sinks used in the instrument. The friction type heat sink is used on A1 and A3 assemblies. The transistors can be removed from the heat sink by carefully pulling the transistors from heat sink with a pair of long-nosed pliers. A heat dissipater casting type of heat sink is used in the low voltage power supply. It is shown in the exploded view in Section VI. The transistors may be removed by removing the two screws that secure them to their sockets.

8-25. CRT REMOVAL AND REPLACEMENT.

WARNING

To prevent personal injury, wear a face mask or goggles when handling the CRT. Wear protective gloves and handle the CRT carefully.

a. Remove plug-ins from oscilloscope.

b. Remove all four covers from Model 180T or top and bottom covers from Model 180TR.

c. On Model 180TR, remove shield next to CRT post accelerator lead (shield is between CRT and plug-in compartment).

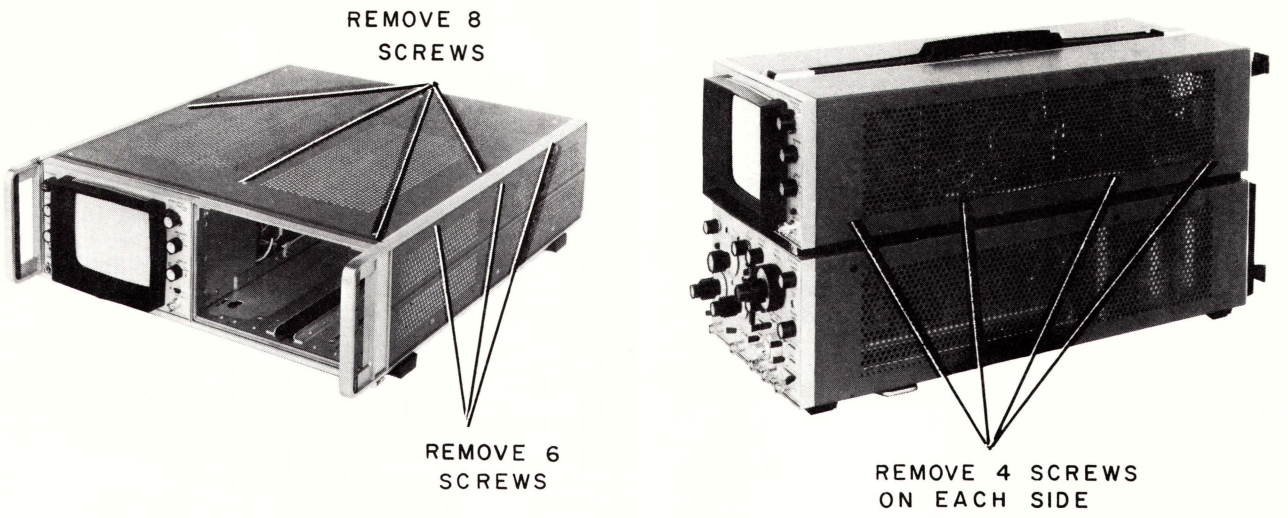


Figure 8-2. Cover Removal

d. Remove flexible three conductor CRT lead from connector block.

e. Remove connections from neck pins on CRT (use long-nosed pliers through access holes).

f. Remove rear display panel.

g. Loosen clamp at rear of CRT.

h. Carefully remove CRT socket.

i. Remove front-panel CRT light shield by squeezing at midpoint, top and bottom.

j. Remove CRT bezel by removing four retaining screws.

k. Place one hand on face of CRT and, with other hand, slide CRT forward and out of instrument. Be careful not to catch neck pins on trace align coil.

l. To install CRT, reverse above procedure. After CRT is installed, perform adjustment procedure in Section V.

8-26. SERVICING CIRCUIT BOARDS.

8-27. Etched circuit boards in this instrument have components mounted on one side of the boards, conductive surfaces on both sides, and plated-through component mounting holes. Hewlett-Packard Service Note M-20E contains useful information on servicing etched circuit boards. Some important considerations are as follows:

a. Use 37- to 47.5-watt chisel tip soldering iron with tip diameter of 1/16 to 1/8 inch, and small diameter resin-core solder.

b. Components may be removed by placing soldering iron on component leads on either side of board and pulling component straight away from board.

c. If component is obviously damaged or faulty, clip leads close to component and then unsolder leads from board.

d. Large components, such as potentiometers, may be removed by rotating soldering iron from lead to lead and applying steady pressure to lift part free. The alternative is to clip leads of damaged part and remove them individually.

e. Excessive heat or force will destory laminate bond between metal plated surface (conductor) and board. If this problem should occur, lifted conductor may be cemented down with small amount of quick-drying acetate-base cement having good insulating properties. Another method of repair is to solder section of good conducting wire along damaged area.

f. Before replacing component, heat remaining solder in component hole and remove with desoldering tool. Sharp pointed metallic tools are not recommended since they may loosen eyelets in boards or remove plating from inside of holes on plated-through etched circuit boards.

g. Tin and shape replacement component leads to fit existing holes.

h. Install replacement component in same position as original. Heat damage may be minimized by gripping lead with long-nosed pliers between soldering iron and component.

8-28. TROUBLESHOOTING TABLES.

8-29. Tables 8-2 through 8-6 provide a guide to locating possible problems.

a. Set Model 180T/TR controls as follows:

Power ..... ON
SCALE ..... OFF
INTENSITY ..... 2 o'clock position
FOCUS ..... as necessary
FIND BEAM ..... as directed
Horizontal DISPLAY ..... EXT
Horizontal MAGNIFIER X1
Horizontal POSITION ..... centered
Vertical POSITION ..... centered
Vertical INPUT ..... none

b. Allow instrument to warm-up and then proceed to table 8-2.

Table 8-2. Preliminary Troubleshooting Tree

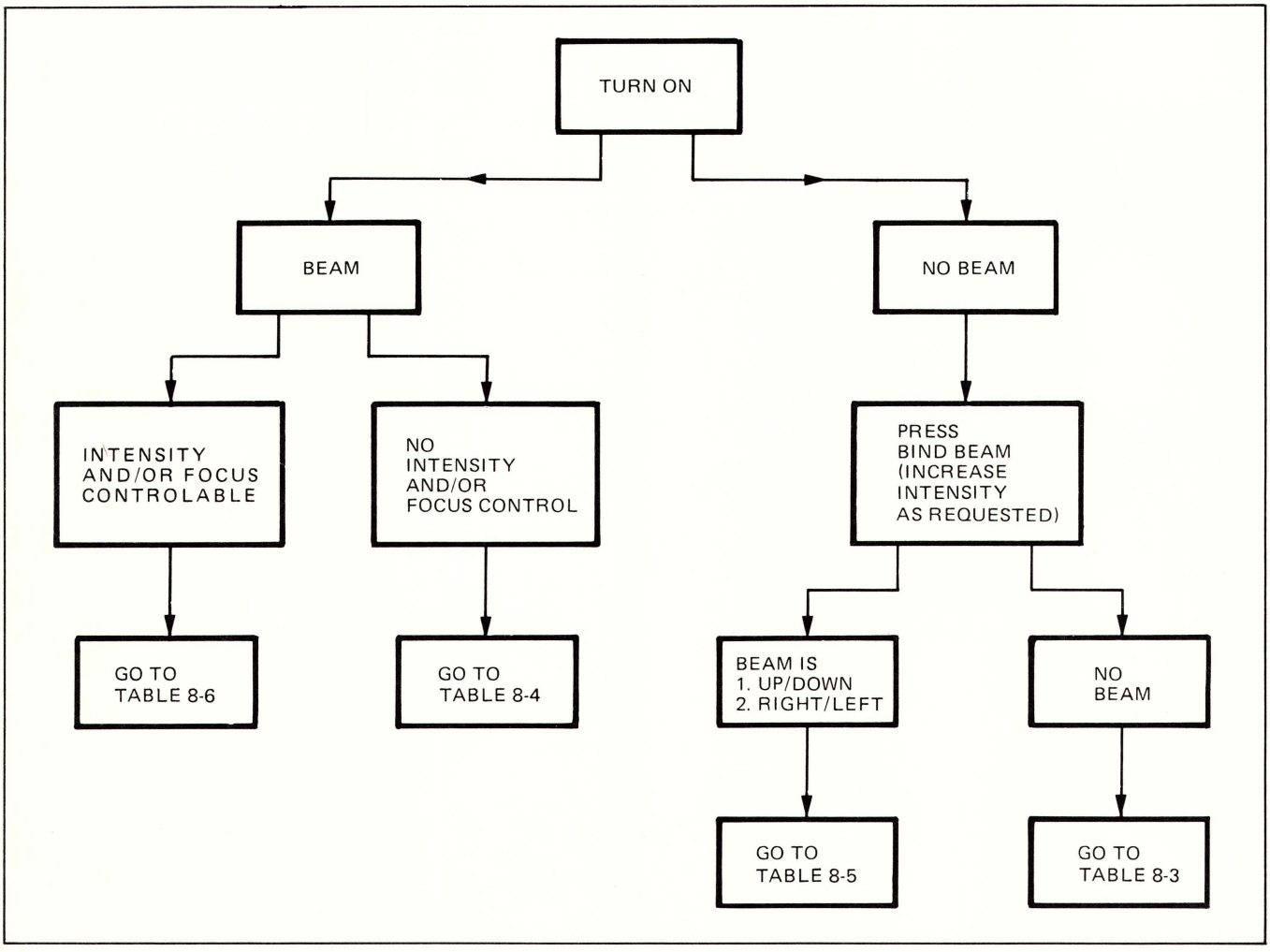


Table 8-3. Troubleshooting No Beam

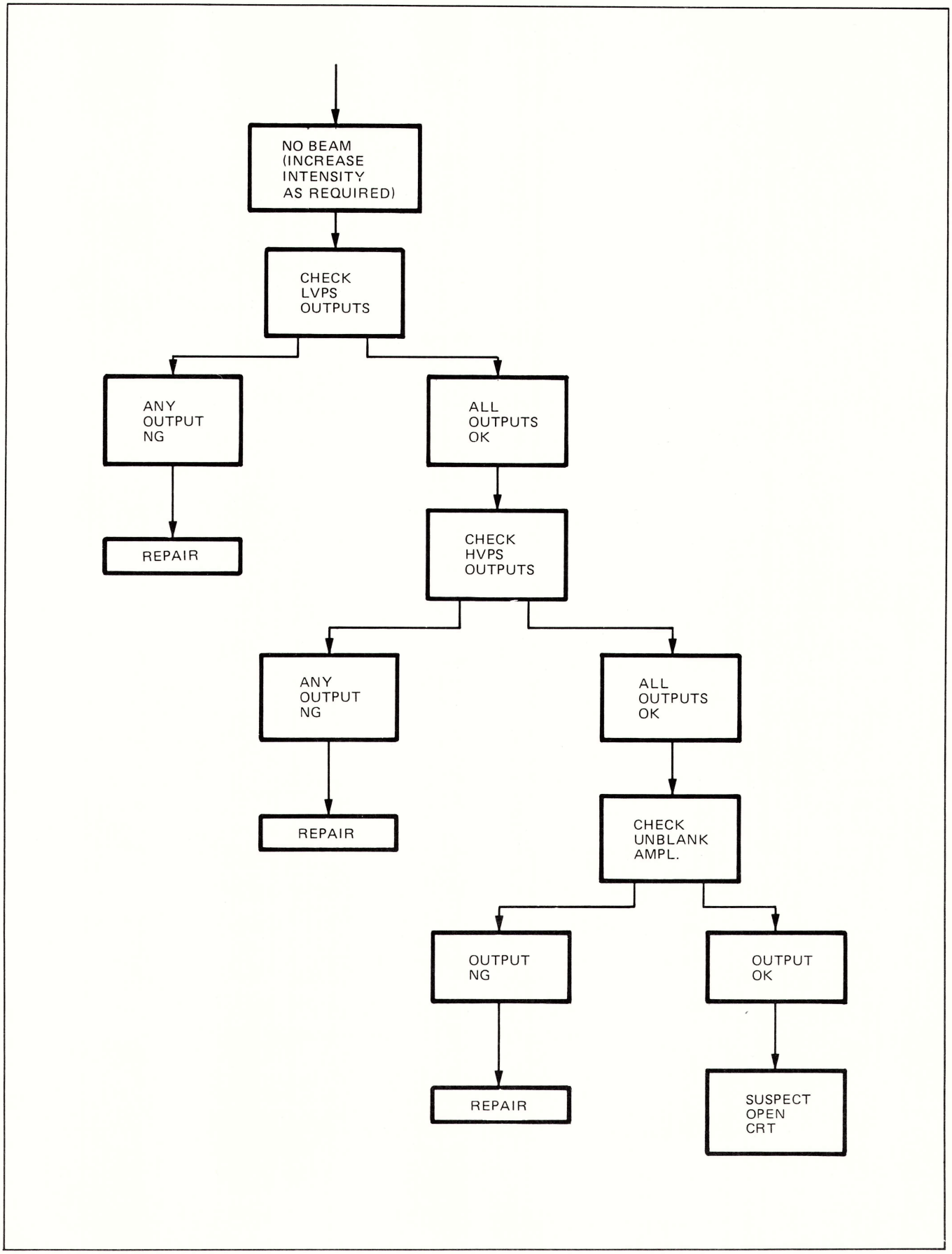


Table 8-4. Troubleshooting Beam Up or Down

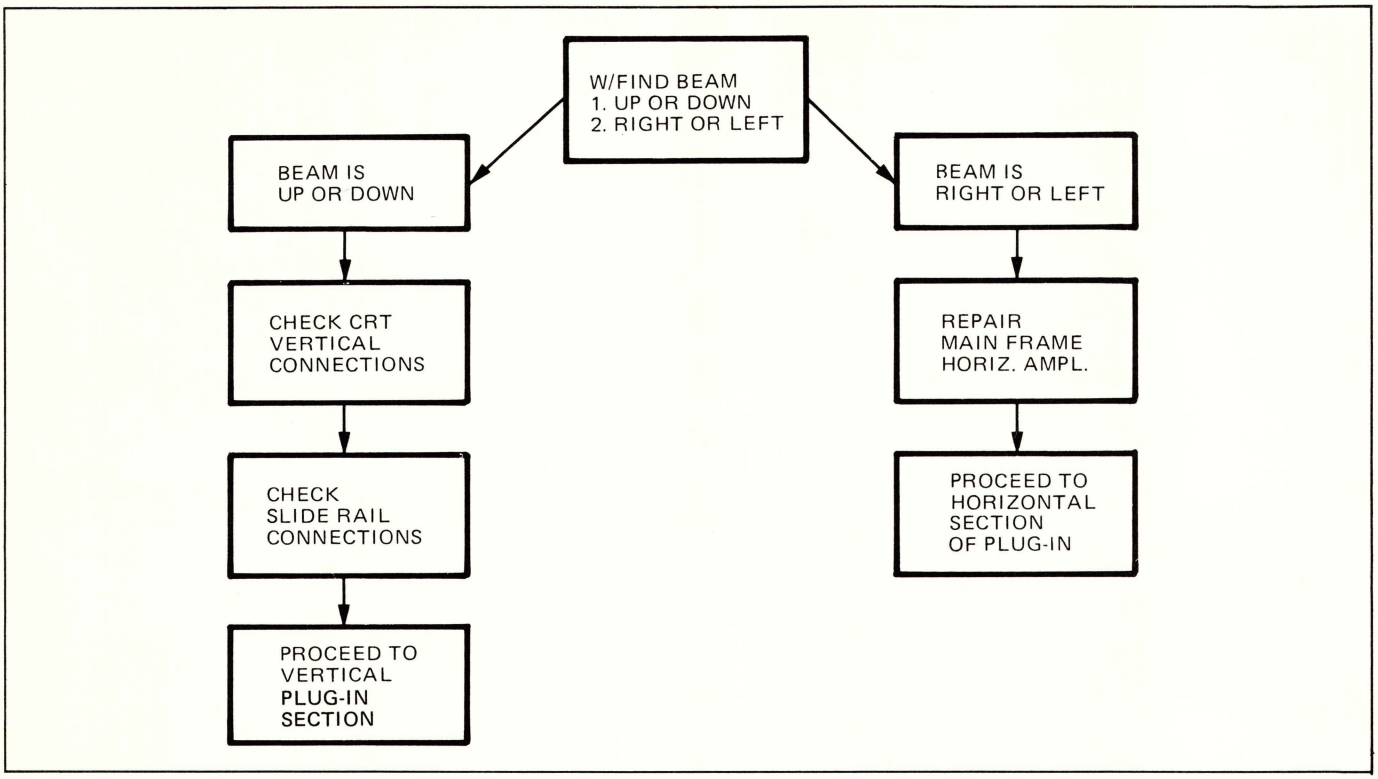


Table 8-5. Troubleshooting Beam Intensity-focus

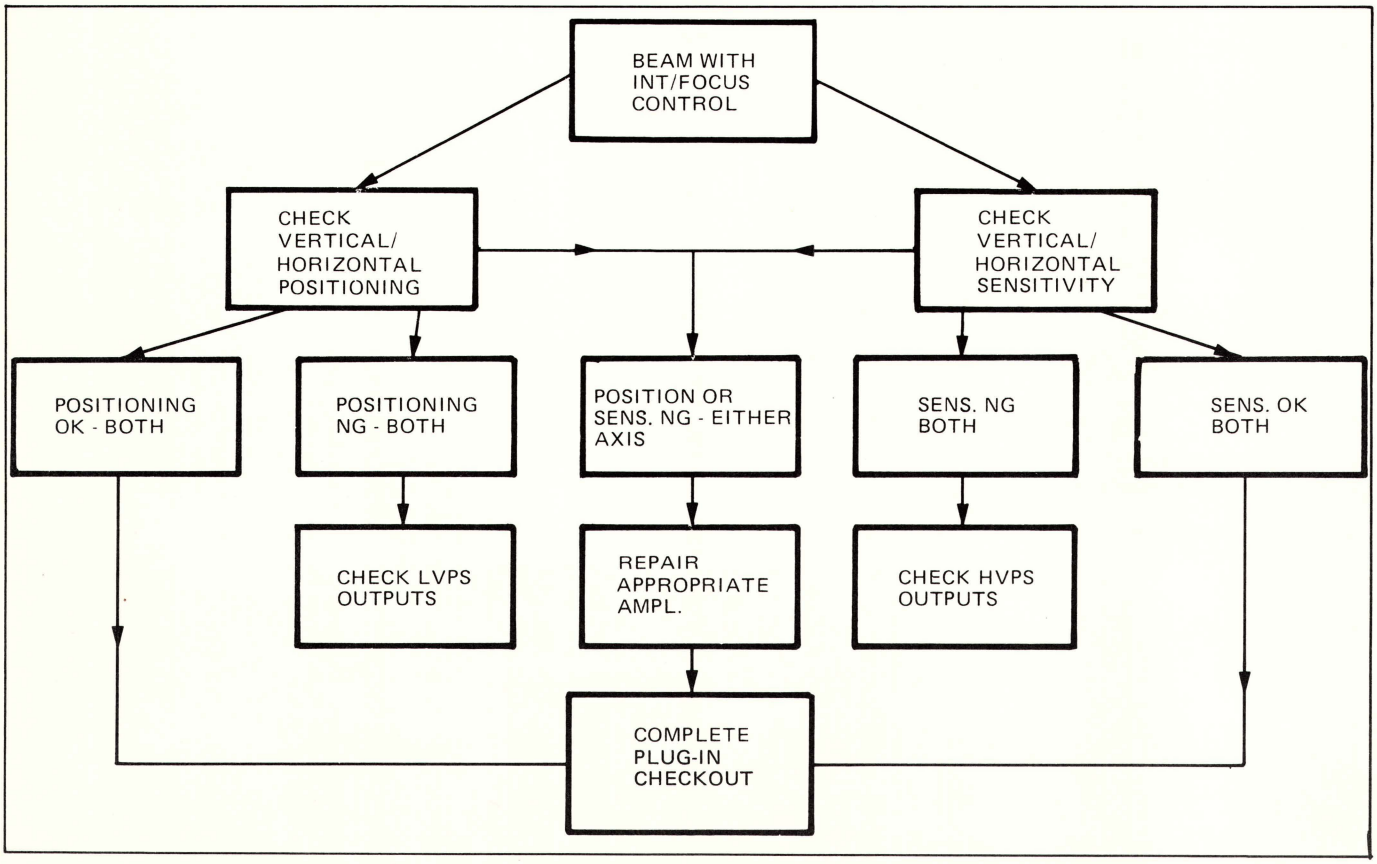


Table 8-6. Troubleshooting Beam No Intensity

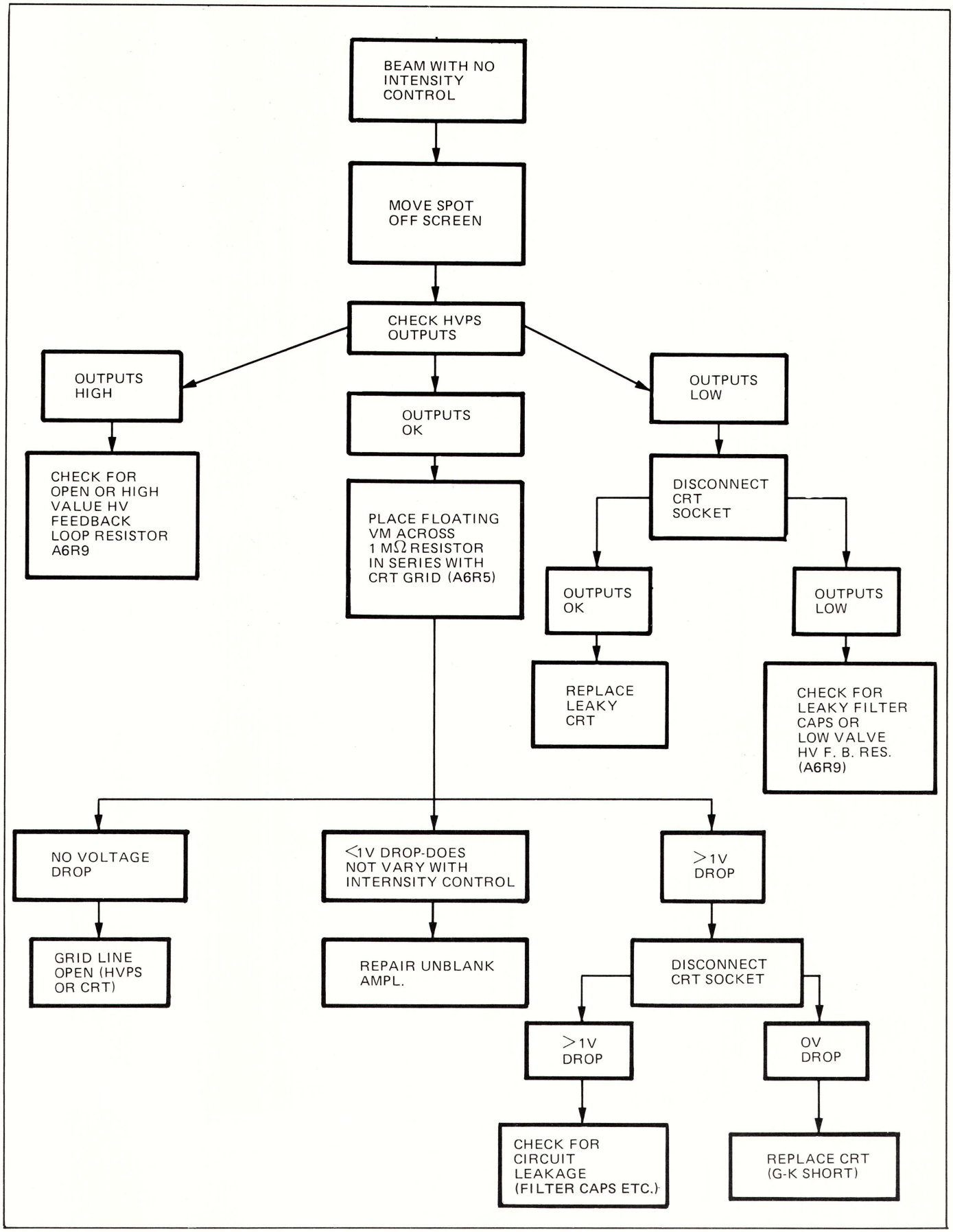
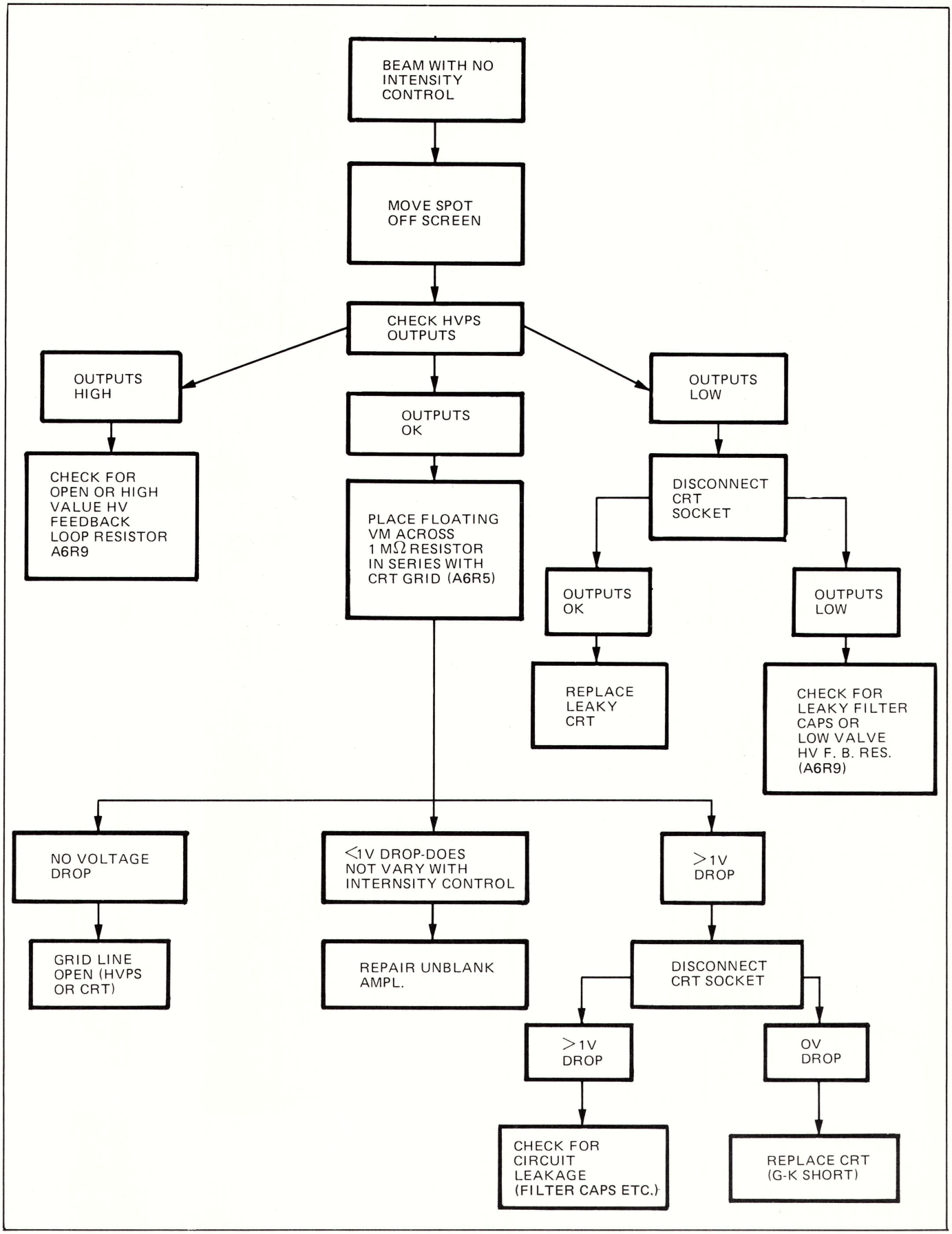

BEAM WITH NO INTENSITY CONTROL
MOVE SPOT OFF SCREEN
CHECK HVPS OUTPUTS
OUTPUTS HIGH
OUTPUTS OK
OUTPUTS LOW
CHECK FOR OPEN OR HIGH VALUE HV FEEDBACK LOOP RESISTOR A6R9
PLACE FLOATING VM ACROSS 1 MΩ RESISTOR IN SERIES WITH CRT GRID (A6R5)
DISCONNECT CRT SOCKET
OUTPUTS OK
OUTPUTS LOW
REPLACE LEAKY CRT
CHECK FOR LEAKY FILTER CAPS OR LOW VALVE HV F. B. RES. (A6R9)
NO VOLTAGE DROP
<1V DROP-DOES NOT VARY WITH INTERNSITY CONTROL
>1V DROP
GRID LINE OPEN (HVPS OR CRT)
REPAIR UNBLANK AMPL.
DISCONNECT CRT SOCKET
>1V DROP
OV DROP
CHECK FOR CIRCUIT LEAKAGE (FILTER CAPS ETC.)
REPLACE CRT (G-K SHORT)

Table 8-6. Troubleshooting Beam No Intensity


BEAM WITH NO INTENSITY CONTROL
MOVE SPOT OFF SCREEN
CHECK HVPS OUTPUTS
OUTPUTS HIGH
OUTPUTS OK
OUTPUTS LOW
CHECK FOR OPEN OR HIGH VALUE HV FEEDBACK LOOP RESISTOR A6R9
PLACE FLOATING VM ACROSS 1 MΩ RESISTOR IN SERIES WITH CRT GRID (A6R5)
DISCONNECT CRT SOCKET
OUTPUTS OK
OUTPUTS LOW
REPLACE LEAKY CRT
CHECK FOR LEAKY FILTER CAPS OR LOW VALVE HV F. B. RES. (A6R9)
NO VOLTAGE DROP
<1V DROP-DOES NOT VARY WITH INTERNSITY CONTROL
>1V DROP
GRID LINE OPEN (HVPS OR CRT)
REPAIR UNBLANK AMPL.
DISCONNECT CRT SOCKET
>1V DROP
OV DROP
CHECK FOR CIRCUIT LEAKAGE (FILTER CAPS ETC.)
REPLACE CRT (G-K SHORT)

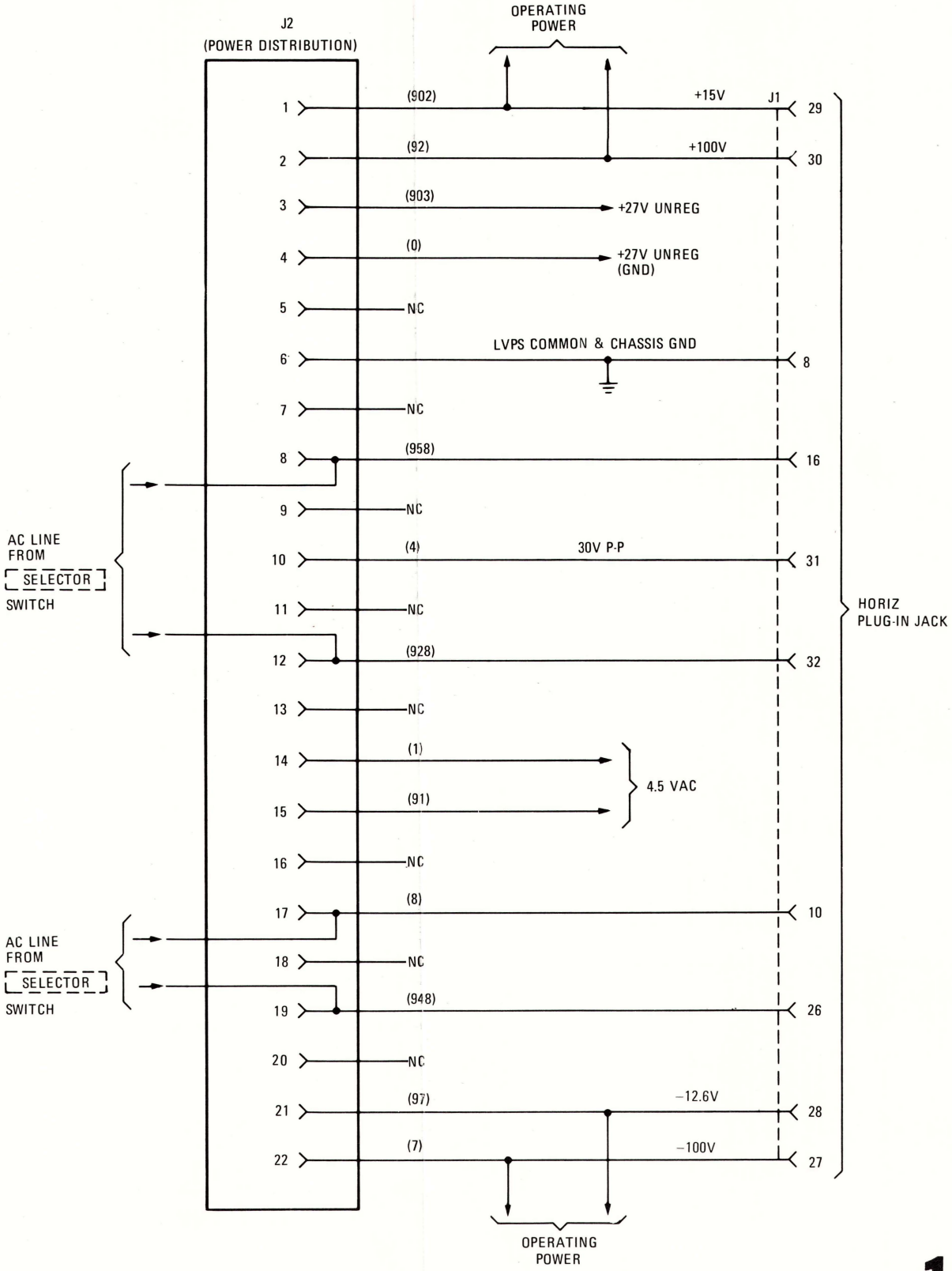
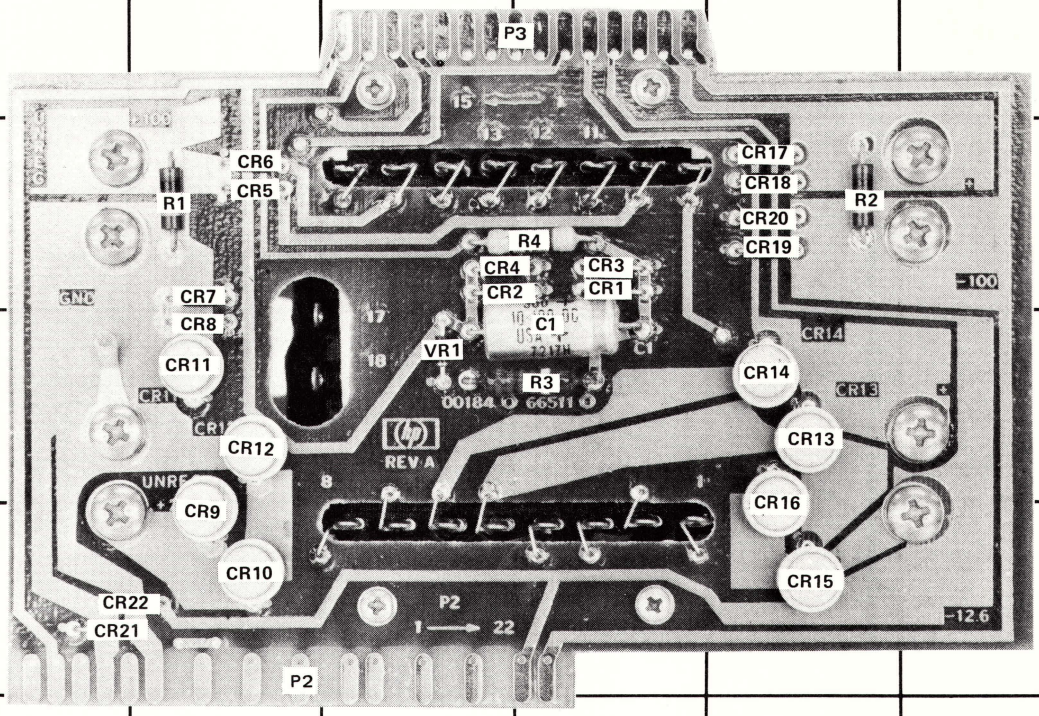


Figure 8-3.
Low Voltage Power Connections



A I A I

Circuit boards have plated through component holes. This permits soldering from either side of the board.

REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	D-3	CR15	E-4
CR1	D-2	CR16	E-4
CR2	C-2	CR17	E-2
CR3	D-2	CR18	E-2
CR4	C-2	CR19	E-2
CR5	B-2	CR20	E-2
CR6	B-2	CR21	A-4
CR7	B-2	CR22	A-4
CR8	B-3	P2	C-4
CR9	B-4	P3	C-1
CR10	B-4	R1	B-2
CR11	B-3	R2	E-2
CR12	B-3	R3	C-3
CR13	E-3	R4	D-2
CR14	E-3	VR1	C-3

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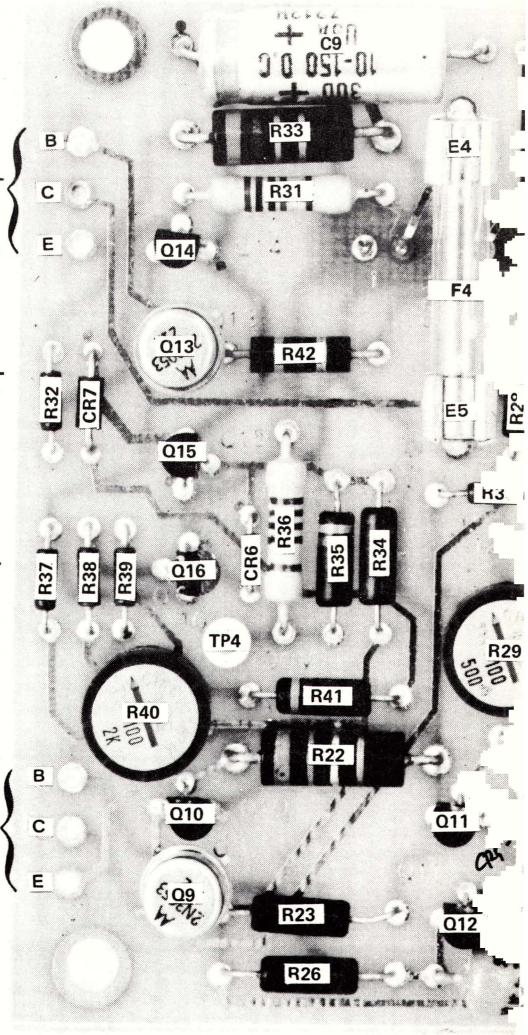
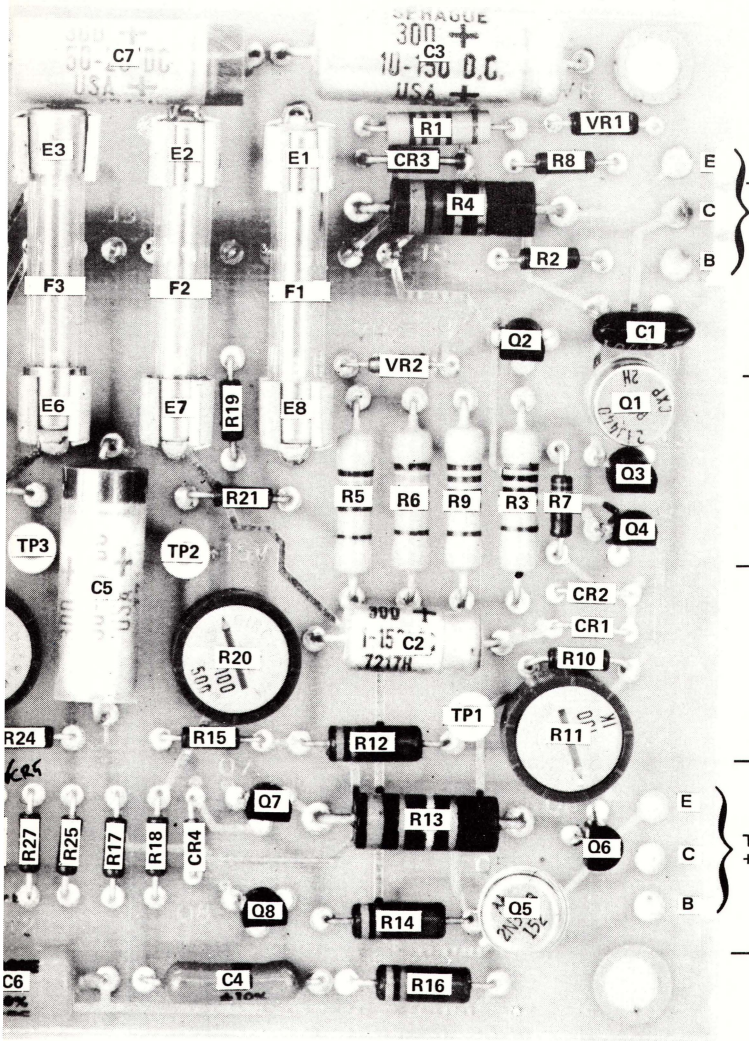
Figure 8-4. Low Voltage Rectifier Component Identification

	A	B	C	D	E	F
1						
2						
3						
4						
5						
6						



Circuit
compon
ing fror

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG
C1	J-2	CR4	G-5	E-7	G-3	Q5
C2	I-4	CR5	F-5	E-8	H-3	Q6
C3	I-1	CR6	E-4	A1F1	H-1	Q7
C4	H-6	CR7	D-3	A1F2	G-2	Q8
C5	G-4	E1	H-1	A1F3	G-2	Q9
C6	F-6	E-2	G-1	A1F4	F-2	Q10
C7	G-1	E-3	G-1	Q1	J-3	Q11
C9	E-1	E-4	F-1	Q2	I-2	Q12
CR1	I-4	E-5	F-3	Q3	J-3	Q13
CR2	I-4	E-6	G-3	Q4	J-3	Q14
CR3	I-1					



oards have plated through
it holes. This permits solder-
either side of the board.

GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
5	Q15	E-3	R9	I-3	R19	H-3	R29	F-4	R39	D-4
5	Q16	E-4	R10	I-4	R20	H-4	R30	F-3	R40	D-4
-5	R1	I-1	R11	I-4	R21	H-3	R31	E-2	R41	E-4
-5	R2	I-2	R12	H-4	R22	E-4	R32	D-3	R42	E-2
-5	R3	I-3	R13	I-5	R23	E-5	R33	E-1	TP1	I-4
-5	R4	I-2	R14	H-5	R24	F-4	R34	F-3	TP2	G-3
-5	R5	H-3	R15	G-4	R25	G-5	R35	E-3	TP3	G-3
-5	R6	I-3	R16	I-6	R26	E-6	R36	E-3	TP4	E-4
-2	R7	I-3	R17	G-5	R27	G-5	R37	D-4	VR1	J-1
-2	R8	I-2	R18	G-5	R28	F-3	R38	D-4	VR2	H-2

180T/TR-036

Figure 8
Low Voltage Regulator Component Identificati
8-11/(8-12 bla

Table 8-7. Low Voltage Power Supply Voltage Measurement Conditions

1. Plug-ins not installed.

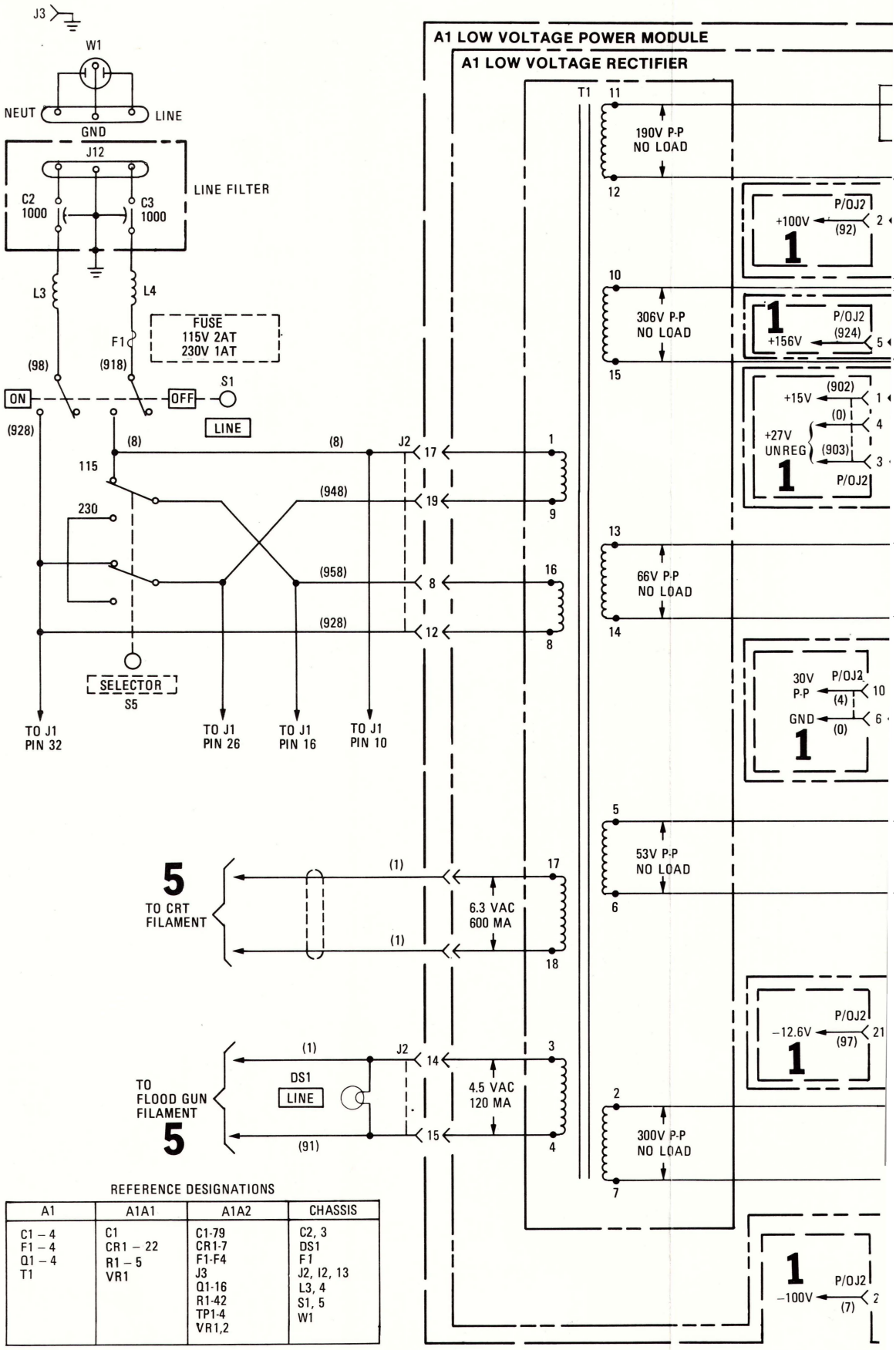
2. LINE power ON.

3. Line voltage 115V or 230V ac.

4. All dc voltages are referenced to ground. Use chassis ground or soldering lug ground located on LV Rectifier board.

5. All dc voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).

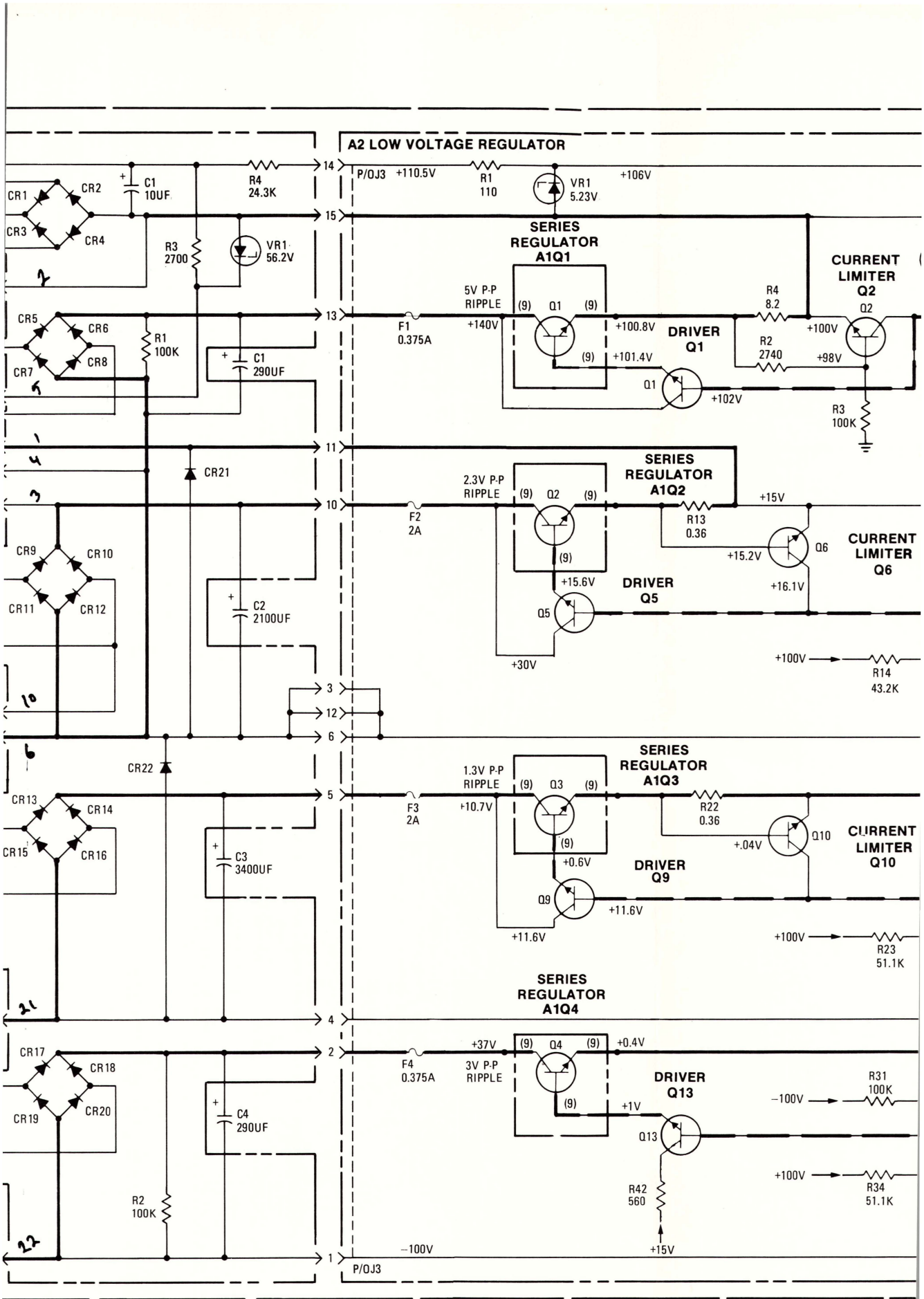
PART 1 OF 4



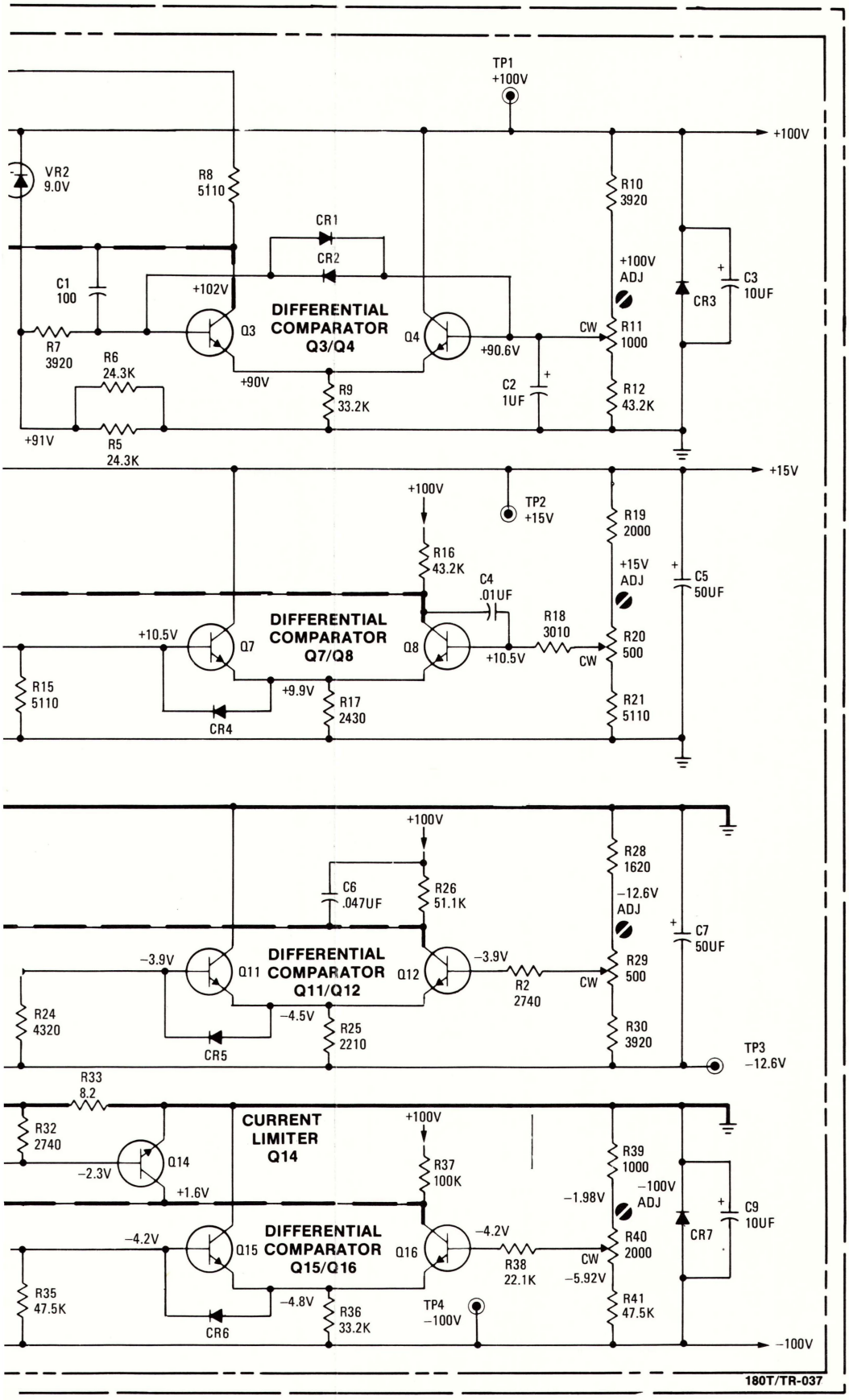
REFERENCE DESIGNATIONS

A1	A1A1	A1A2	CHASSIS
C1 – 4 F1 – 4 Q1 – 4 T1	C1 CR1 – 22 R1 – 5 VR1	C1-79 CR1-7 F1-F4 J3 Q1-16 R1-42 TP1-4 VR1,2	C2, 3 DS1 F1 J2, I2, 13 L3, 4 S1, 5 W1

PART 2 OF 4


A2 LOW VOLTAGE REGULATOR
P/OJ3
+110.5V
R1
110
VR1
5.23V
+106V
14
15
13
11
10
3
12
6
5
4
2
1
P/OJ3
CR1
CR2
CR3
CR4
C1
10UF
R4
24.3K
R3
2700
VR1
56.2V
CR5
CR6
CR7
CR8
R1
100K
C1
290UF
CR21
CR9
CR10
CR11
CR12
C2
2100UF
CR22
CR13
CR14
CR15
CR16
C3
3400UF
CR17
CR18
CR19
CR20
C4
290UF
R2
100K
SERIES
REGULATOR
A1Q1
5V P-P
RIPPLE
(9)
Q1
(9)
+140V
F1
0.375A
+100.8V
DRIVER
Q1
+101.4V
Q1
+102V
R4
8.2
R2
2740
CURRENT
LIMITER
Q2
Q2
+100V
+98V
R3
100K
SERIES
REGULATOR
A1Q2
2.3V P-P
RIPPLE
(9)
Q2
(9)
F2
2A
+15V
R13
0.36
+15.2V
Q6
CURRENT
LIMITER
Q6
+16.1V
(9)
+15.6V
DRIVER
Q5
Q5
+30V
+100V
R14
43.2K
SERIES
REGULATOR
A1Q3
1.3V P-P
RIPPLE
(9)
Q3
(9)
F3
2A
+10.7V
R22
0.36
+.04V
Q10
CURRENT
LIMITER
Q10
(9)
+0.6V
DRIVER
Q9
Q9
+11.6V
+11.6V
+100V
R23
51.1K
SERIES
REGULATOR
A1Q4
+37V
(9)
Q4
(9)
+0.4V
F4
0.375A
3V P-P
RIPPLE
(9)
DRIVER
Q13
+1V
Q13
R31
100K
−100V
+100V
R34
51.1K
R42
560
+15V
−100V
P/OJ3

PART 3 OF 4

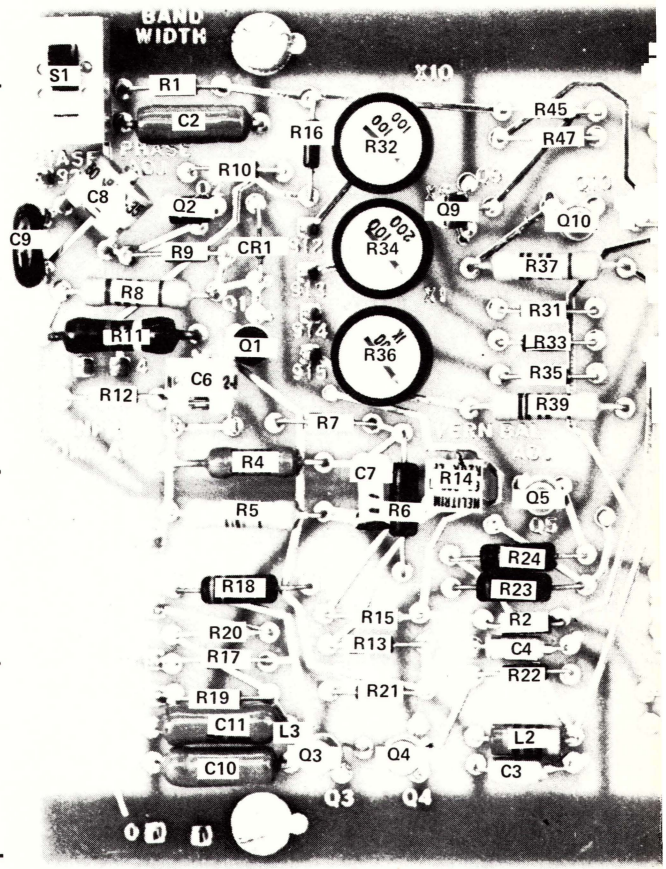


2

Figure 8-6.
Low Voltage Power Supply Schematic 2

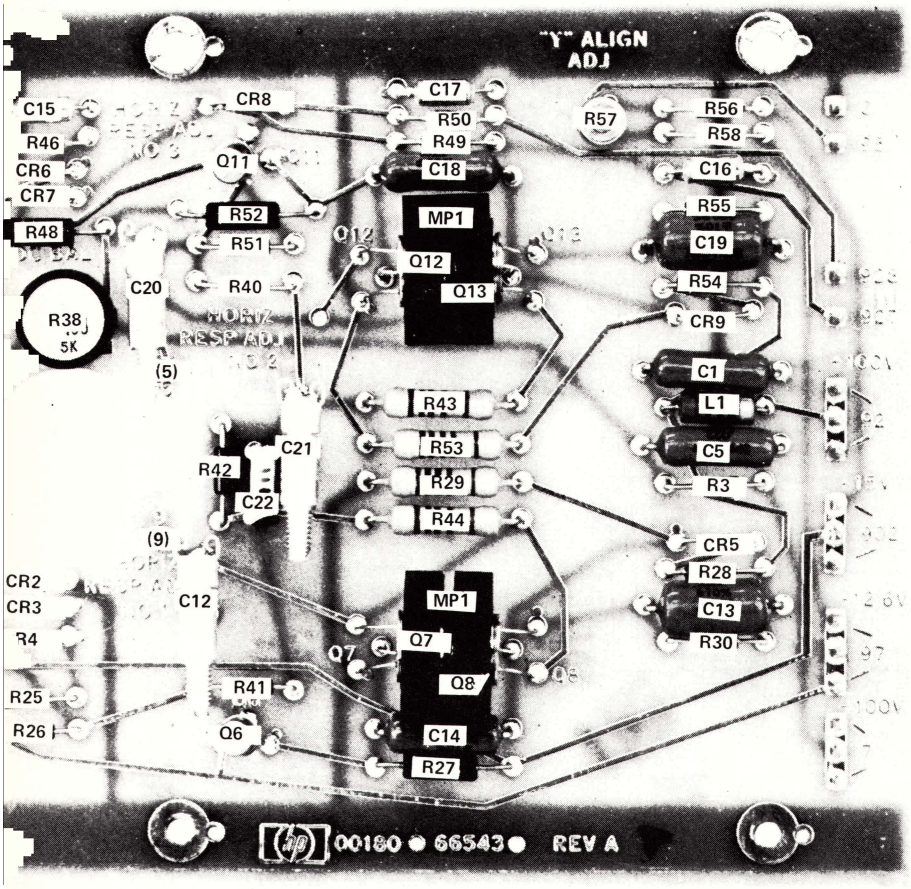
PART 4 OF 4

	A	B	C	D	E	F
1						
2						
3						
4						
5						
6						



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	J-3	C15	G-2	CR7	G-2
C2	D-2	C16	J-2	CR8	H-2
C3	F-5	C17	I-1	CR9	J-3
C4	F-4	C18	I-2	L1	J-3
C5	J-3	C19	J-2	L2	F-5
C6	D-3	C20	G-3	L3	D-5
C7	E-4	C21	H-3	MP1	I-2
C8	D-2	C22	H-4	Q1	D-3
C9	C-2	CR1	D-2	Q2	D-2
C10	D-5	CR2	G-4	Q3	E-5
C11	D-5	CR3	G-4	Q4	E-5
C12	G-4	CR4	G-4	Q5	F-4
C13	J-4	CR5	J-4	Q6	H-5
C14	I-5	CR6	G-2	Q7	I-4

PART 1 OF 2



Circuit boards have plated through component holes. This permits soldering from either side of the board.

A 2

REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
28	I-5	R8	D-3	R21	E-5	R34	E-2	R47	F-2
29	E-2	R9	D-2	R22	F-5	R35	F-3	R48	G-2
210	F-2	R10	D-2	R23	F-4	R36	E-3	R49	I-2
211	H-2	R11	D-3	R24	F-4	R37	F-2	R50	I-2
212	I-2	R12	D-3	R25	G-5	R38	G-3	R51	H-2
13	I-3	R13	E-4	R26	G-5	R39	F-3	R52	H-2
31	D-1	R14	E-4	R27	I-5	R40	H-3	R53	I-3
32	F-4	R15	E-4	R28	J-4	R41	H-5	R54	J-2
3	J-4	R16	E-2	R29	I-4	R42	H-3	R55	J-2
34	D-3	R17	D-4	R30	J-4	R43	I-3	R56	J-2
35	D-4	R18	D-4	R31	F-3	R44	I-4	R57	J-2
36	E-4	R19	D-5	R32	E-2	R45	F-2	R58	J-2
7	E-3	R20	D-4	R33	F-3	R46	G-2	S1	C-1

180T/TR-038

Figure 8-7. Horizontal Amplifier Component Identification

PART 2 OF 2

Table 8-8. Horizontal Amplifier Voltage Measurement Conditions

1. Plug-ins not installed.

2. LINE power ON.

3. No signal input.

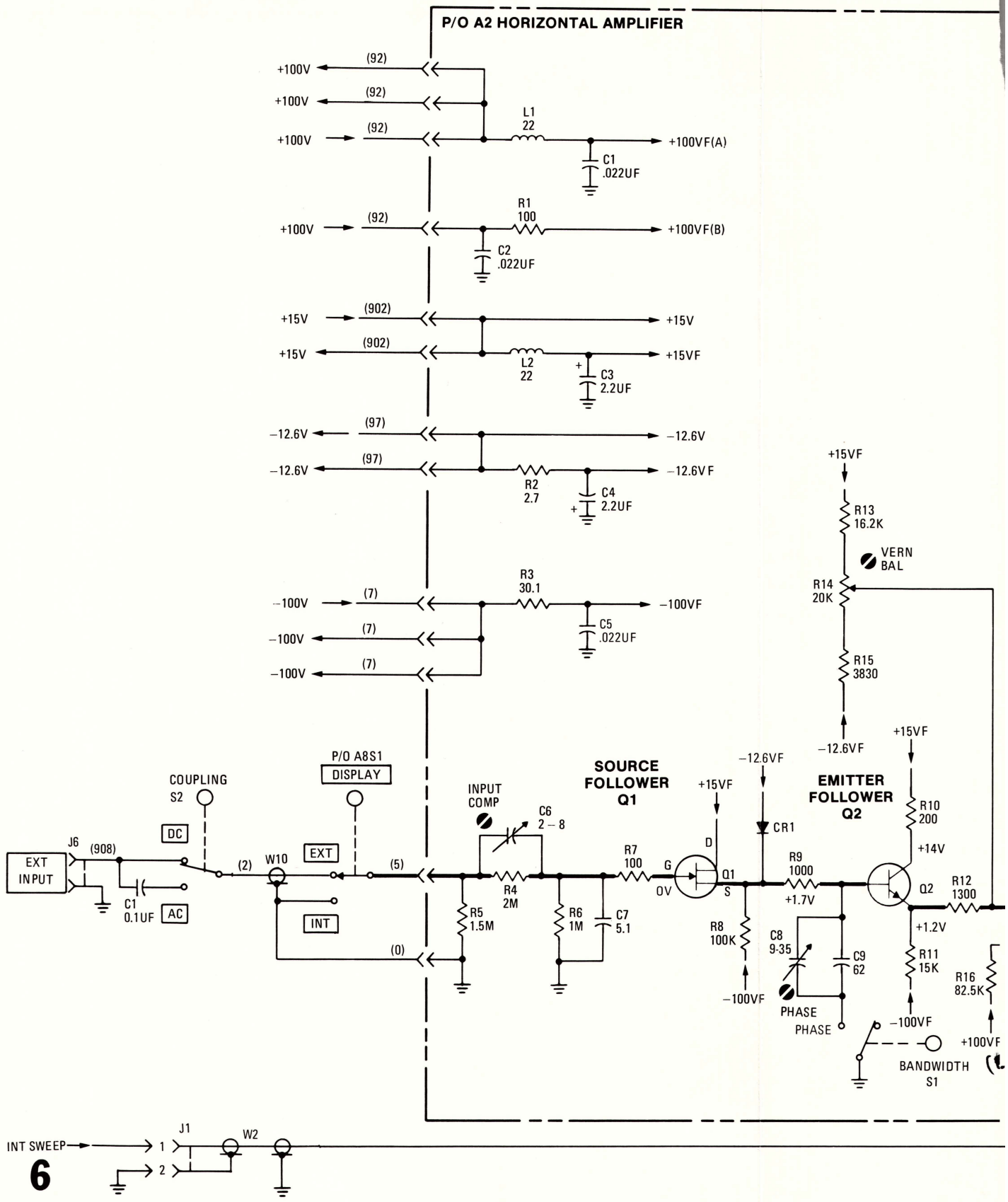
4. Set controls as follows:

INTENSITY	fully ccw
SCALE	OFF
FOCUS	fully ccw
POSITION	centered
DISPLAY	EXT CAL
MAGNIFIER	X1

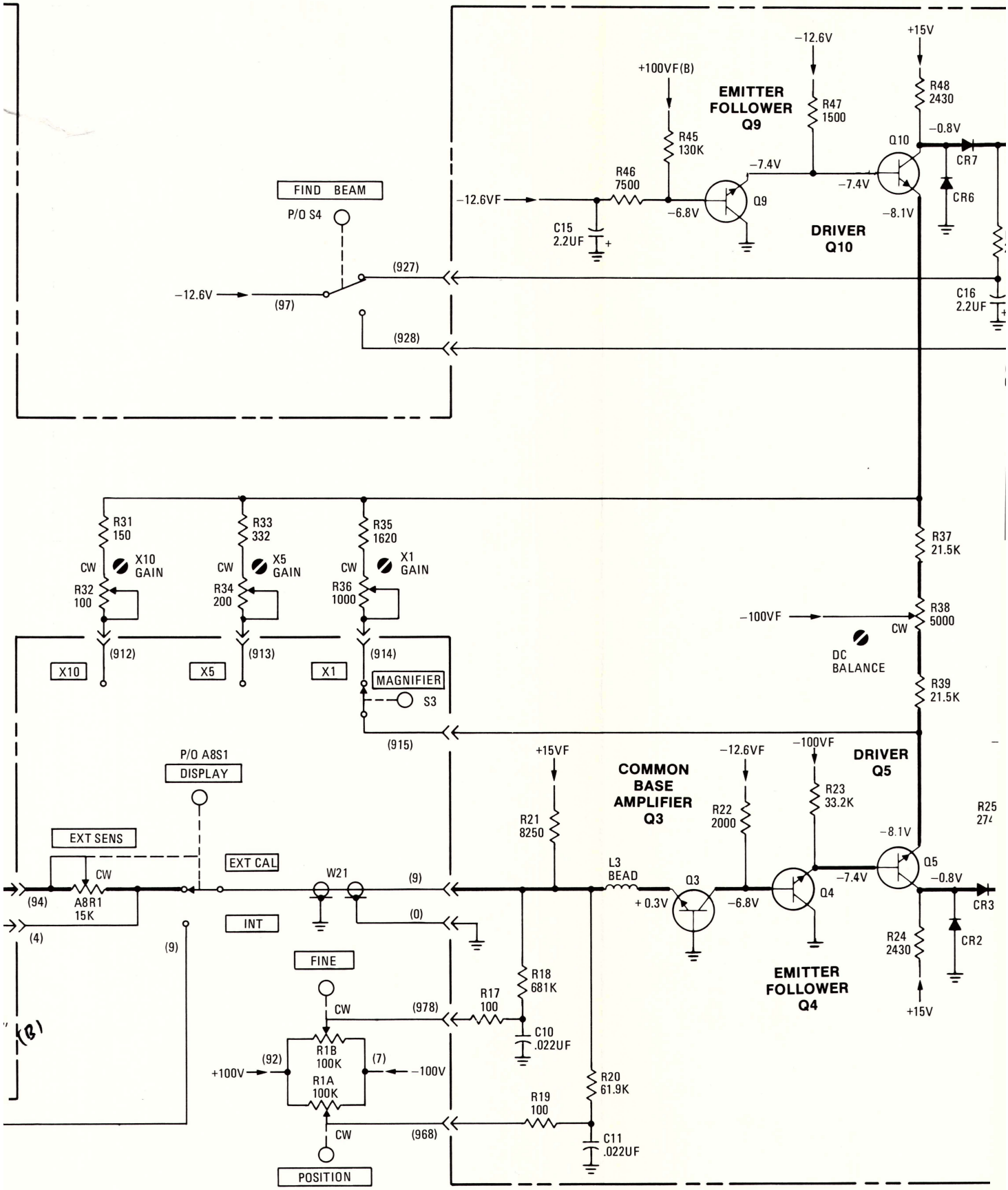
5. All voltages referenced to ground.

6. All voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).

PART 1 OF 4


P/O A2 HORIZONTAL AMPLIFIER
+100V
(92)
+100V
(92)
+100V
(92)
L1
22
+100VF(A)
C1
.022UF
+100V
(92)
R1
100
+100VF(B)
C2
.022UF
+15V
(902)
+15V
+15V
(902)
+15VF
L2
22
C3
2.2UF
−12.6V
(97)
−12.6V
−12.6V
(97)
−12.6VF
R2
2.7
C4
2.2UF
−100V
(7)
R3
30.1
−100VF
C5
.022UF
−100V
(7)
−100V
(7)
+15VF
R13
16.2K
VERN
BAL
R14
20K
R15
3830
−12.6VF
P/O A8S1
DISPLAY
COUPLING
S2
DC
AC
J6
(908)
EXT
INPUT
C1
0.1UF
(2)
W10
EXT
INT
(5)
(0)
INPUT
COMP
C6
2 – 8
R4
2M
R5
1.5M
R6
1M
C7
5.1
SOURCE
FOLLOWER
Q1
R7
100
G
D
S
Q1
OV
+15VF
−12.6VF
CR1
R8
100K
−100VF
R9
1000
+1.7V
C8
9-35
C9
62
PHASE
PHASE
EMITTER
FOLLOWER
Q2
+15VF
R10
200
+14V
Q2
R12
1300
+1.2V
R11
15K
−100VF
R16
82.5K
+100VF
BANDWIDTH
S1
INT SWEEP
J1
1
2
W2
6

PART 2 OF 4


+100VF(B)
EMITTER FOLLOWER Q9
−12.6V
+15V
R48 2430
R47 1500
R45 130K
−0.8V
Q10
CR7
R46 7500
−7.4V
−7.4V
CR6
FIND BEAM
P/O S4
−12.6VF
Q9
−6.8V
−8.1V
DRIVER Q10
C15 2.2UF
(927)
−12.6V
(97)
C16 2.2UF
(928)
R31 150
R33 332
R35 1620
R37 21.5K
CW
X10 GAIN
CW
X5 GAIN
CW
X1 GAIN
R32 100
R34 200
R36 1000
−100VF
R38 5000
CW
DC BALANCE
X10
(912)
X5
(913)
X1
(914)
MAGNIFIER
S3
R39 21.5K
(915)
P/O A8S1
DISPLAY
+15VF
COMMON BASE AMPLIFIER Q3
−12.6VF
−100VF
DRIVER Q5
R21 8250
R22 2000
R23 33.2K
R25 27
EXT SENS
CW
EXT CAL
W21
(9)
L3 BEAD
Q3
−8.1V
Q5
(94)
A8R1 15K
INT
(0)
+ 0.3V
−6.8V
Q4
−7.4V
−0.8V
CR3
(4)
(9)
R24 2430
CR2
FINE
R18 681K
EMITTER FOLLOWER Q4
+15V
R17 100
CW
(978)
C10 .022UF
R1B 100K
(92)
(7)
+100V
−100V
R1A 100K
R20 61.9K
R19 100
CW
(968)
C11 .022UF
POSITION

PART 3 OF 4

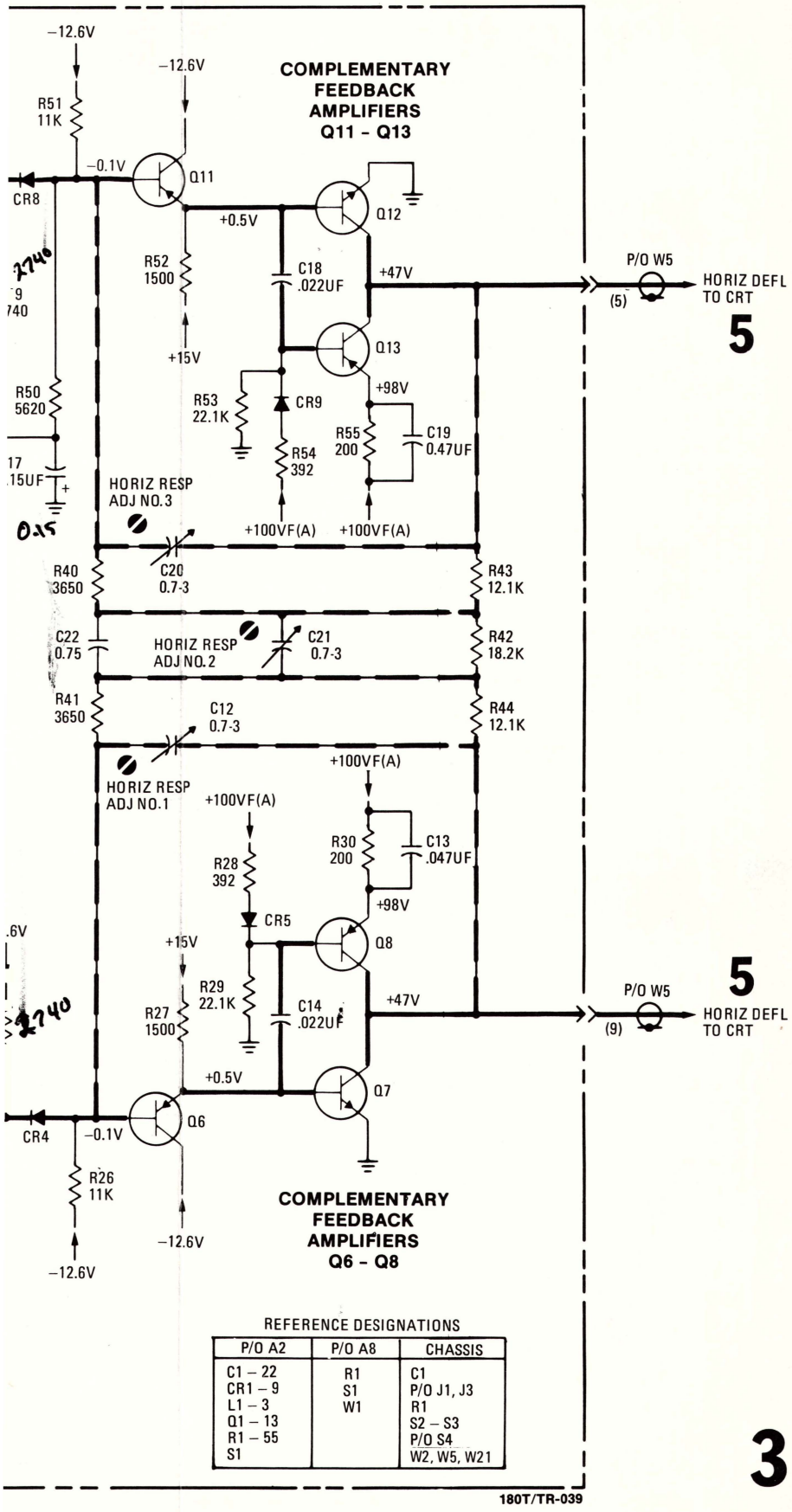
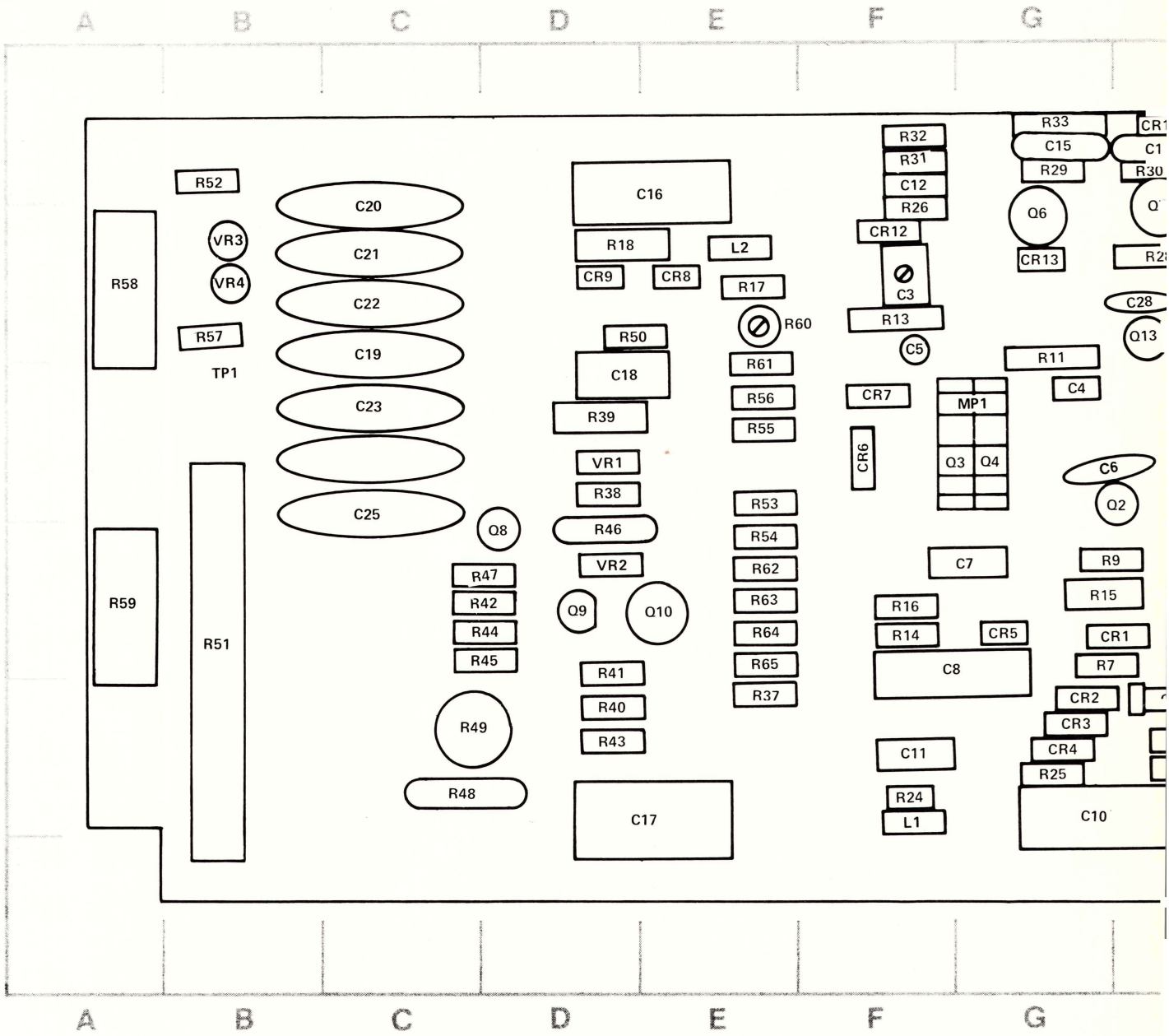
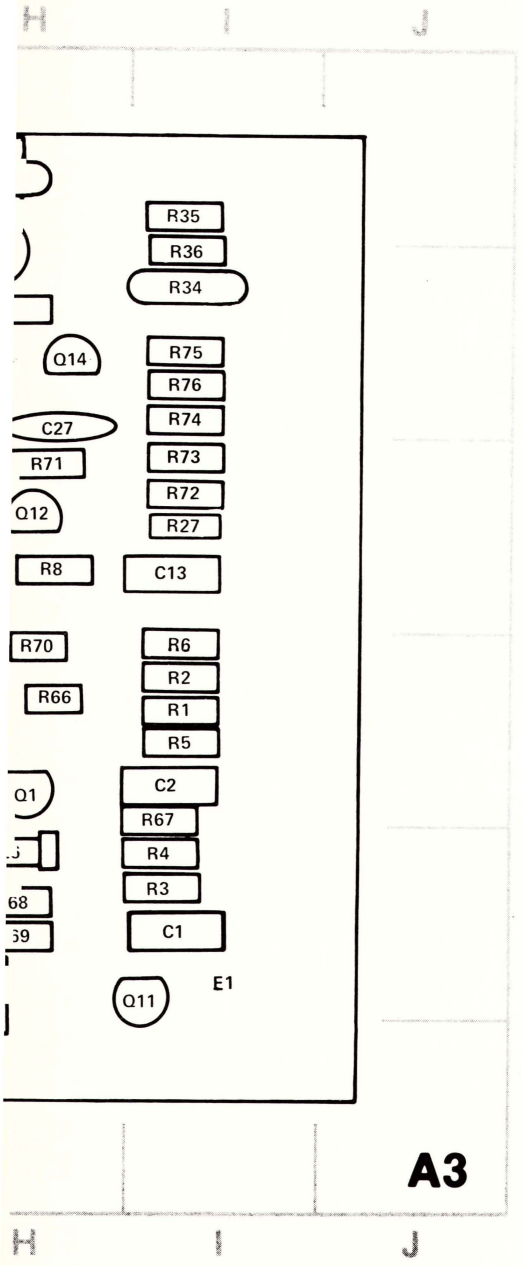


Figure 8-8.
Horizontal Amplifier Schematic 3


A
B
C
D
E
F
G
1
2
3
4
5
6
R52
R58
VR3
VR4
R57
TP1
C20
C21
C22
C19
C23
C25
R59
R51
C16
R18
CR9
CR8
L2
R17
R60
R50
C18
R39
VR1
R38
R46
VR2
Q8
R47
R42
R44
R45
Q9
Q10
R49
R48
R41
R40
R43
C17
R53
R54
R62
R63
R64
R65
R37
R61
R56
R55
R32
R31
C12
R26
CR12
C3
R13
C5
CR7
CR6
MP1
Q3
Q4
C7
R16
R14
CR5
C8
C11
R24
L1
R33
C15
R29
Q6
CR13
R11
C4
C6
Q2
R9
R15
CR1
R7
CR2
CR3
CR4
R25
C10
C28
Q13



REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC	REF DESIG	GRID LOC
C1	I-5	CR7	F-3	R13	F-2	R50	D-2
C2	I-4	CR8	E-2	R14	F-4	R51	B-4
C3	F-2	CR9	D-2	R15	G-4	R52	B-1
C4	G-3	CR11	H-1	R16	F-4	R53	E-3
C5	F-2	CR12	F-2	R17	E-2	R54	E-4
C6	G-3	CR13	G-2	R18	D-2	R55	E-3
C7	G-4	E1	I-5	R24	F-5	R56	E-3
C8	F-4	L1	F-5	R25	G-5	R57	B-2
C10	G-5	L2	E-2	R26	F-2	R58	A-2
C11	F-5	MP1	G-3	R27	I-3	R59	A-4
C12	F-1	Q1	H-4	R28	H-2	R60	E-2
C13	I-3	Q2	G-3	R29	G-1	R61	E-2
C14	H-1	Q3	G-3	R30	H-1	R62	E-4
C15	G-1	Q4	G-3	R31	F-1	R63	E-4
C16	E-1	Q6	G-2	R32	F-1	R64	E-4
C17	E-5	Q7	H-1	R33	G-1	R65	E-4
C18	D-3	Q8	D-4	R34	I-2	R66	H-4
C19	C-2	Q9	D-4	R35	I-1	R67	I-4
C20	C-2	Q10	E-4	R36	I-2	R68	H-5
C21	C-2	Q11	I-5	R37	E-5	R69	H-5
C22	C-2	Q12	H-3	R38	D-3	R70	H-4
C23	C-3	Q13	H-2	R39	D-3	R71	H-3
C24	C-3	Q14	H-2	R40	D-5	R72	I-3
C25	C-3	R1	I-4	R41	D-4	R73	I-3
C26	H-5	R2	I-4	R42	D-4	R74	I-2
C27	H-2	R3	I-5	R43	D-5	R75	I-2
C28	H-2	R4	I-5	R44	D-4	R76	I-2
CR1	H-4	R5	I-4	R45	D-4	TP1	B-3
CR2	G-5	R6	I-4	R46	D-4	VR1	D-3
CR3	G-5	R7	G-4	R47	D-4	VR2	D-4
CR4	G-5	R8	H-3	R48	C-5	VR3	B-2
CR5	G-4	R9	G-4	R49	C-5	VR4	B-2
CR6	F-3	R11	G-3				

180T/TR-040

Figure 8-9. Gate Amplifier Component Identification

Table 8-9. Gate Amplifier and H. V. Regulator Voltage Measurement Conditions

1. Plug-ins not installed.
2. LINE power ON.
3. No signal input.
4. Set controls as follows:

INTENSITY	fully ccw
SCALE	OFF
FOCUS	fully ccw
POSITION	centered
DISPLAY	EXT CAL
MAGNIFIER	X1

5. All voltages referenced to ground.
6. All voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).

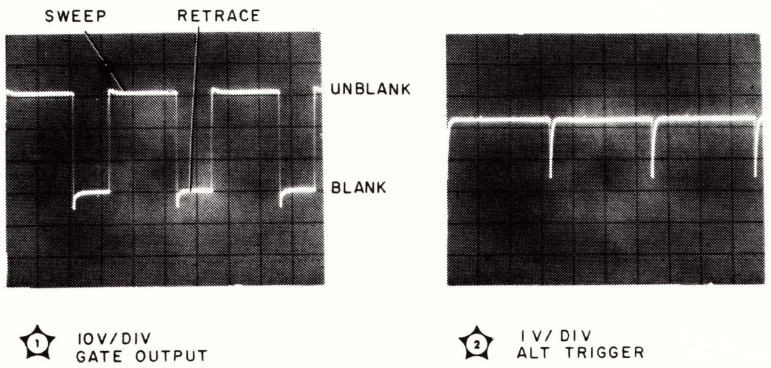
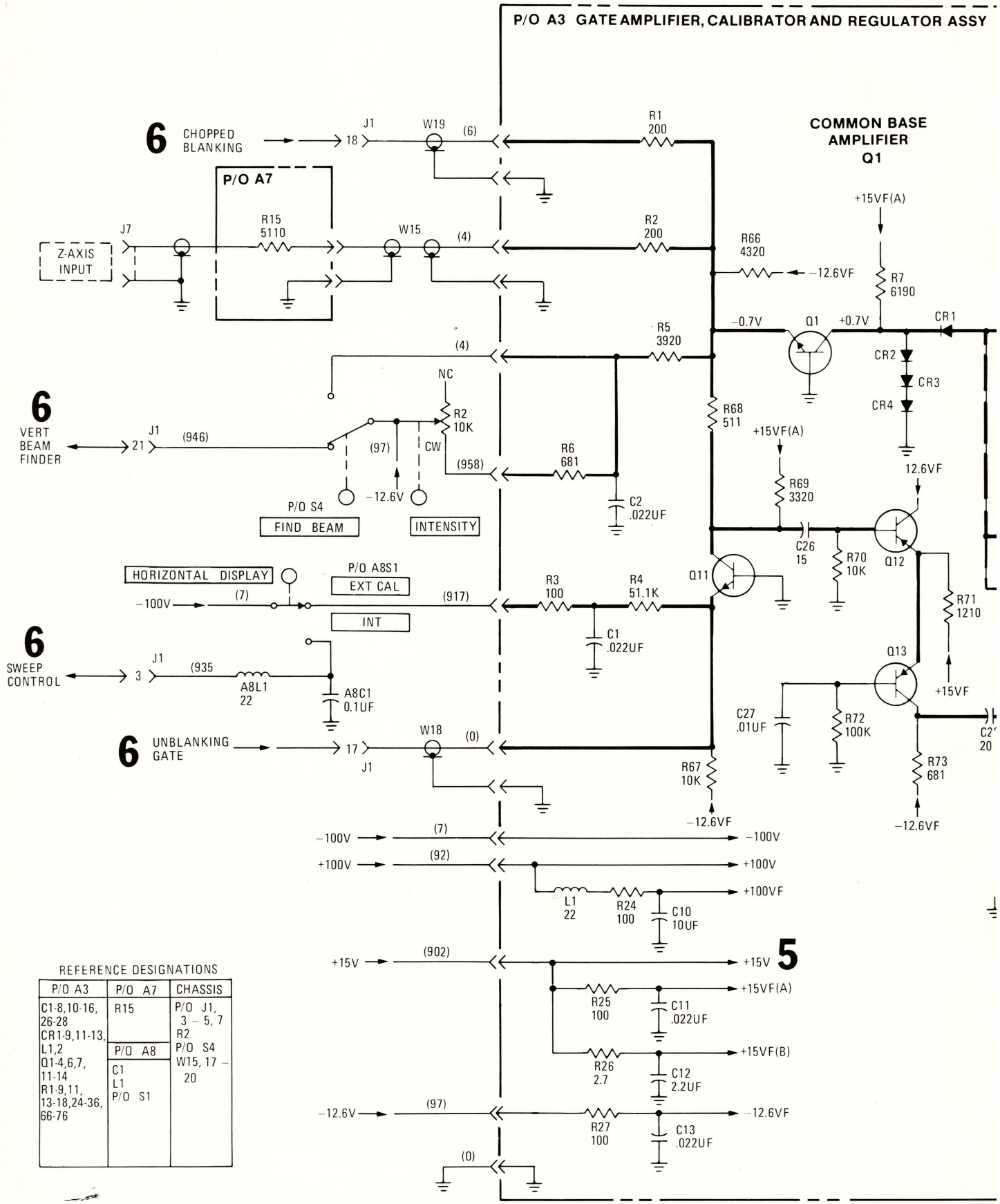


Figure 8-10. Gate Amplifier Waveforms

PART 1 OF 3



REFERENCE DESIGNATIONS

P/O A3	P/O A7	CHASSIS
C1-8,10-16, 26-28 CR1-9,11-13, L1,2 Q1-4,6,7, 11-14 R1-9,11, 13-18,24-36, 66-76	R15 P/O A8 C1 L1 P/O S1	P/O J1, 3 – 5, 7 R2 P/O S4 W15, 17 – 20

PAGE 2 OF 3

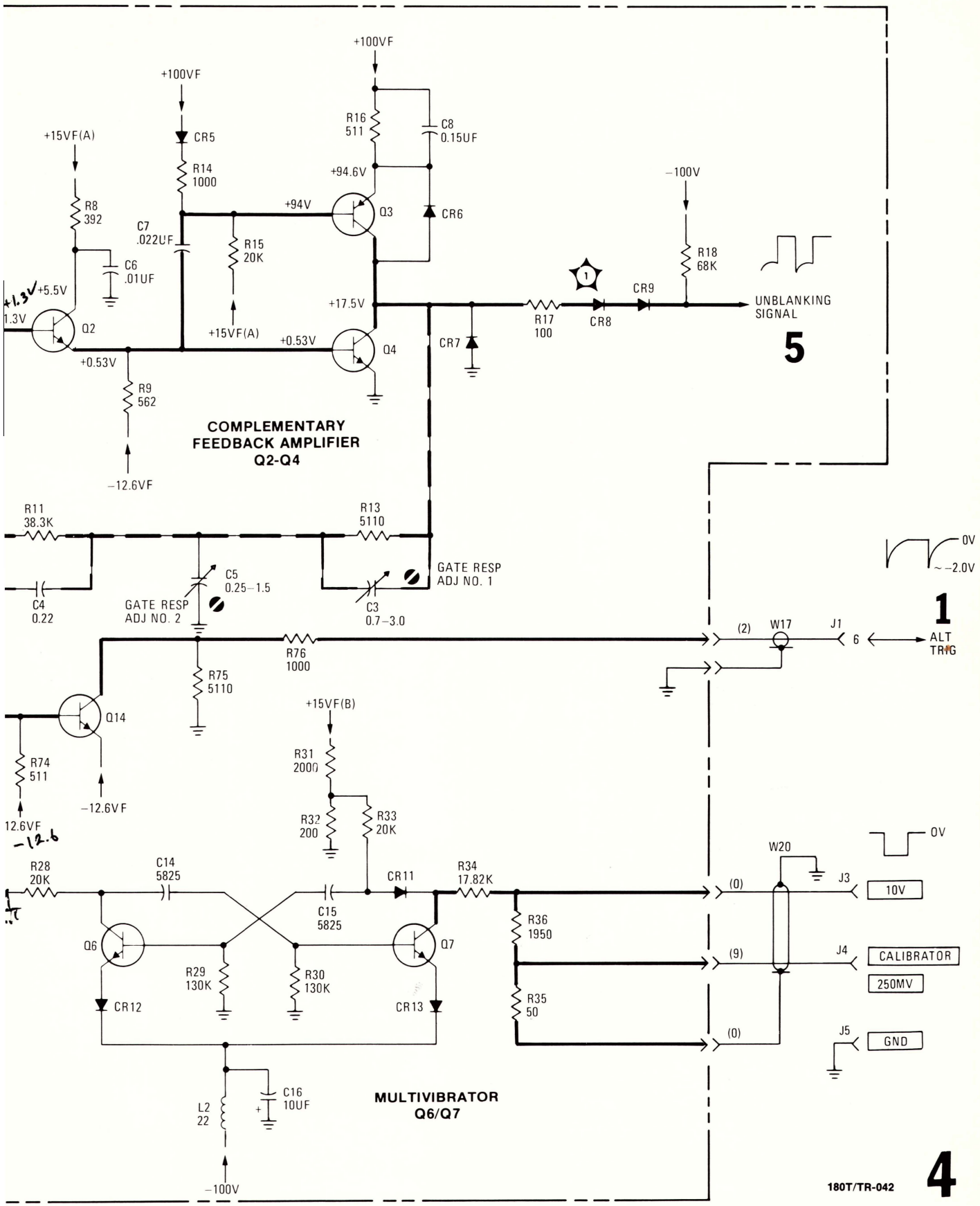


Figure 8-11.
Gate Amplifier and Calibrator Schematic 4

PART 3 OF 3

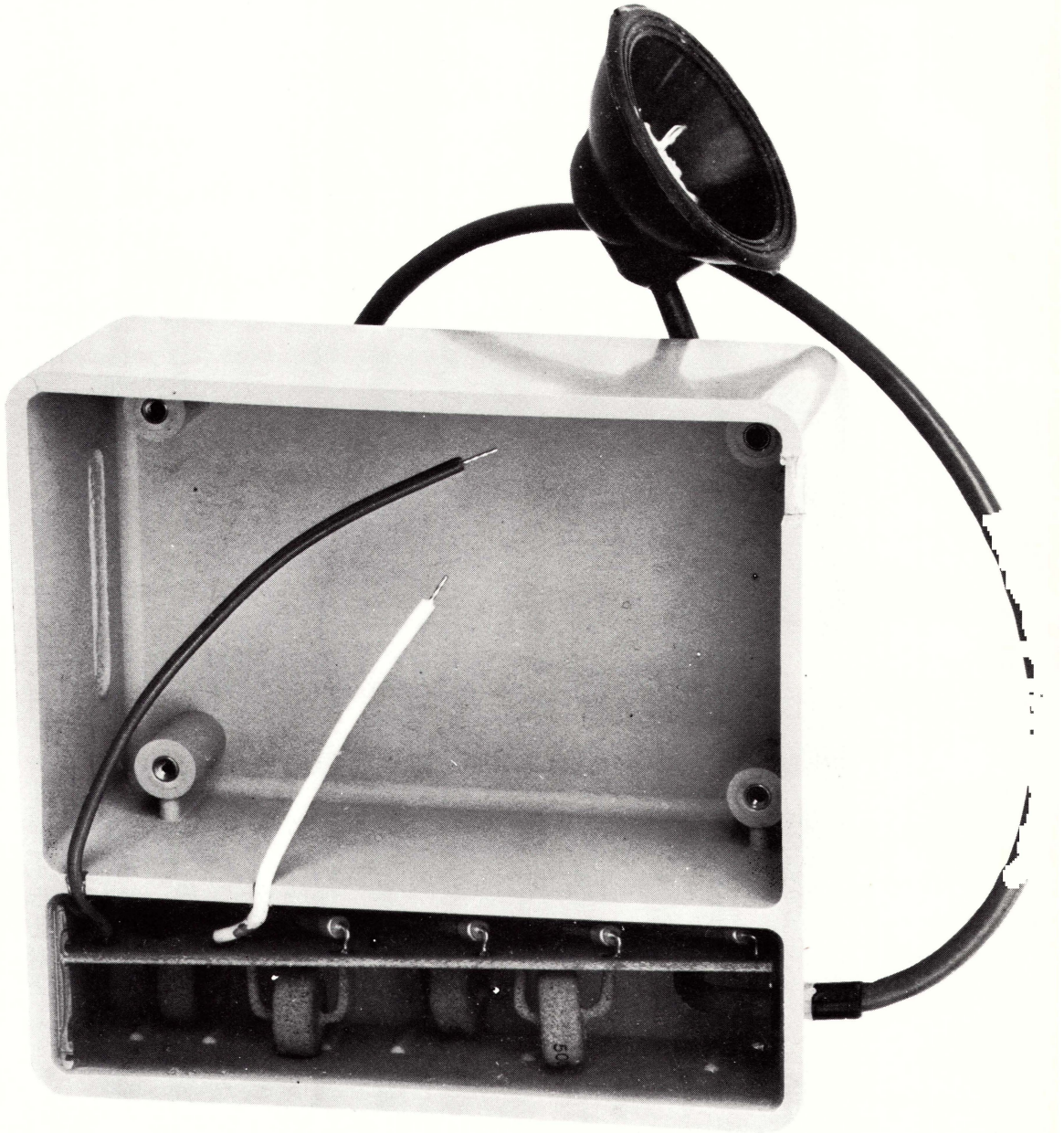
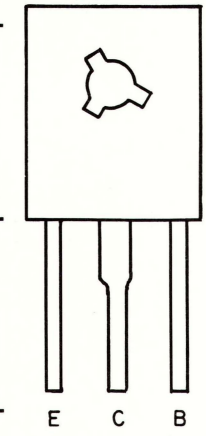
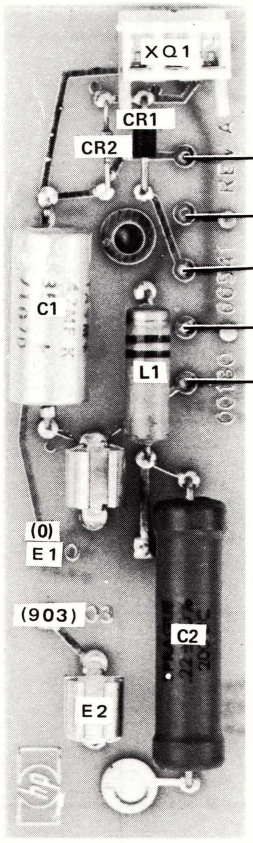


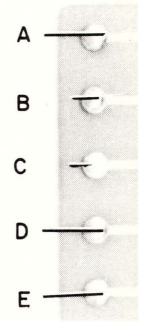
Figure 8-12. H. V. Multiplier

PART 1 OF 3

	A	B	C	D	E	F
1						
2						
3						
4						
5						
6						



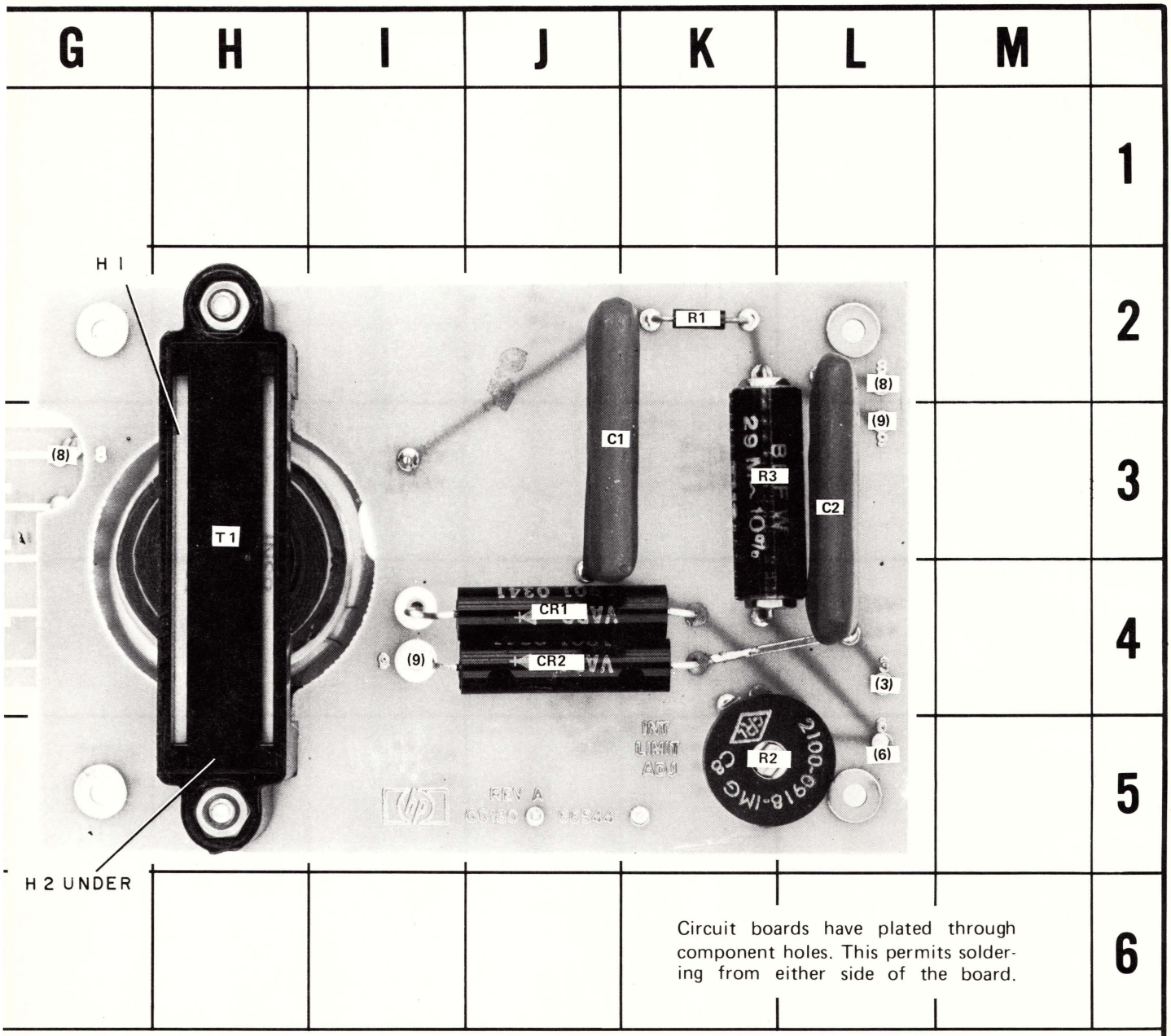




A4

REF DESIG	GRID LOC
C1	C-3
C2	D-5
CR1	D-2
CR2	C-2
E1	C-4
E2	C-5
L1	D-3
XQ1	D-2

PART 2 OF 3



A 5

REF DESIG	GRID LOC
C1	J-3
C2	L-3
CR1	J-4
CR2	J-4
R1	K-2
R2	L-5
R3	K-3
T1	H-3

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Figure 8-13. H. V. Oscillator and Rectifier Component

PAGE 30F3

Table 8-10. H.V. Power Supply Voltage Measurement Conditions

1. Plug-ins not installed.

2. LINE power ON.

3. No signal input.

4. Set controls as follows:

   INTENSITY ..... fully ccw

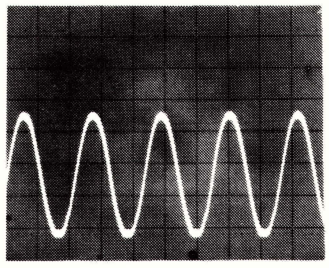
   SCALE ..... OFF

   FOCUS ..... fully ccw

5. All dc voltages referenced to ground.

6. Low voltages measured with HP Model 414A Auto Voltmeter (100 MΩ input impedance).

7. To measure high voltages, use HP Model K05-3440A 1000:1 Divider Probe and HP Model 3440A Digital Voltmeter with HP Model 3441A or 3444A plug-in.

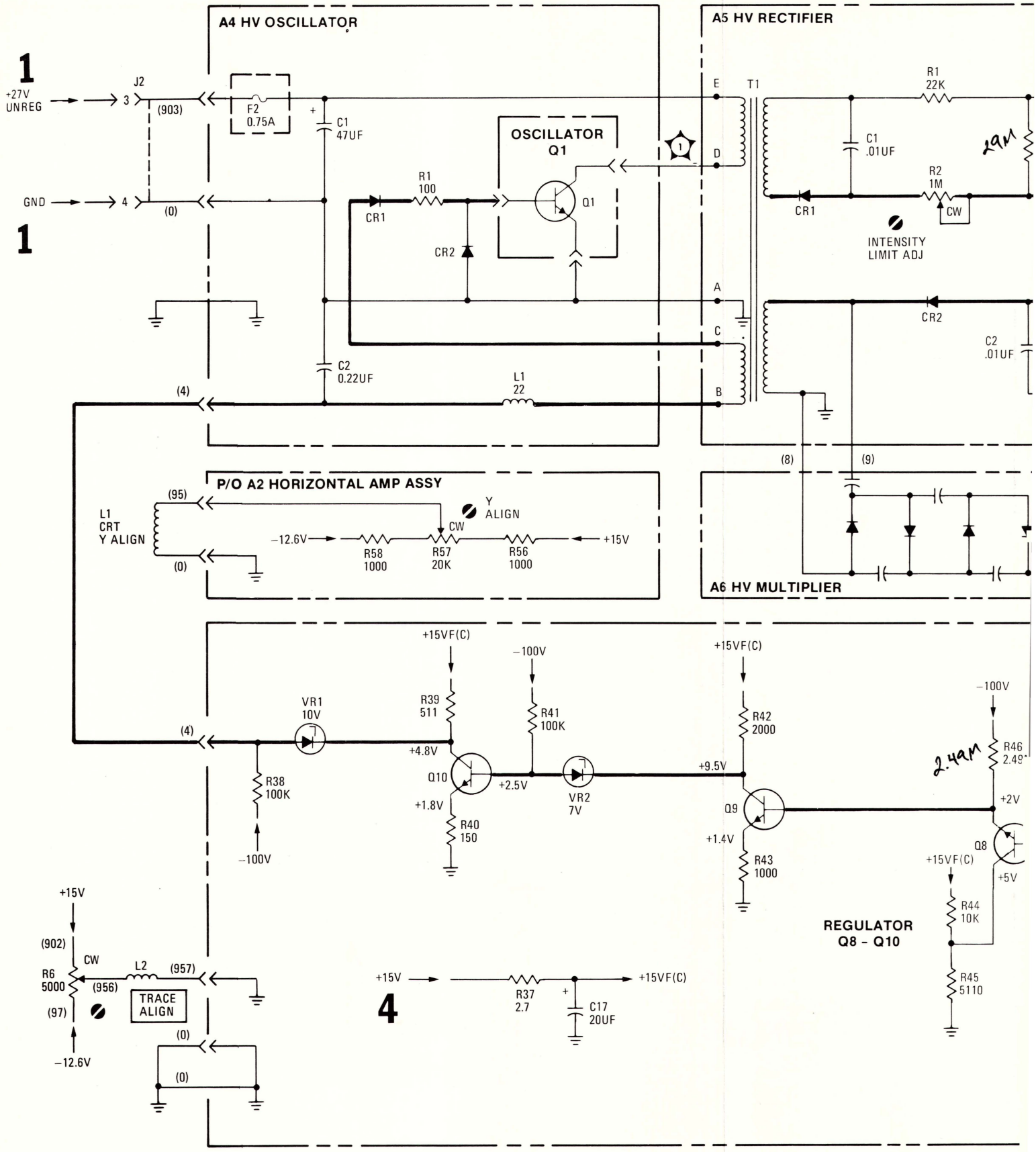


1 10V/DIV
COLLECTOR, H.V. OSC.

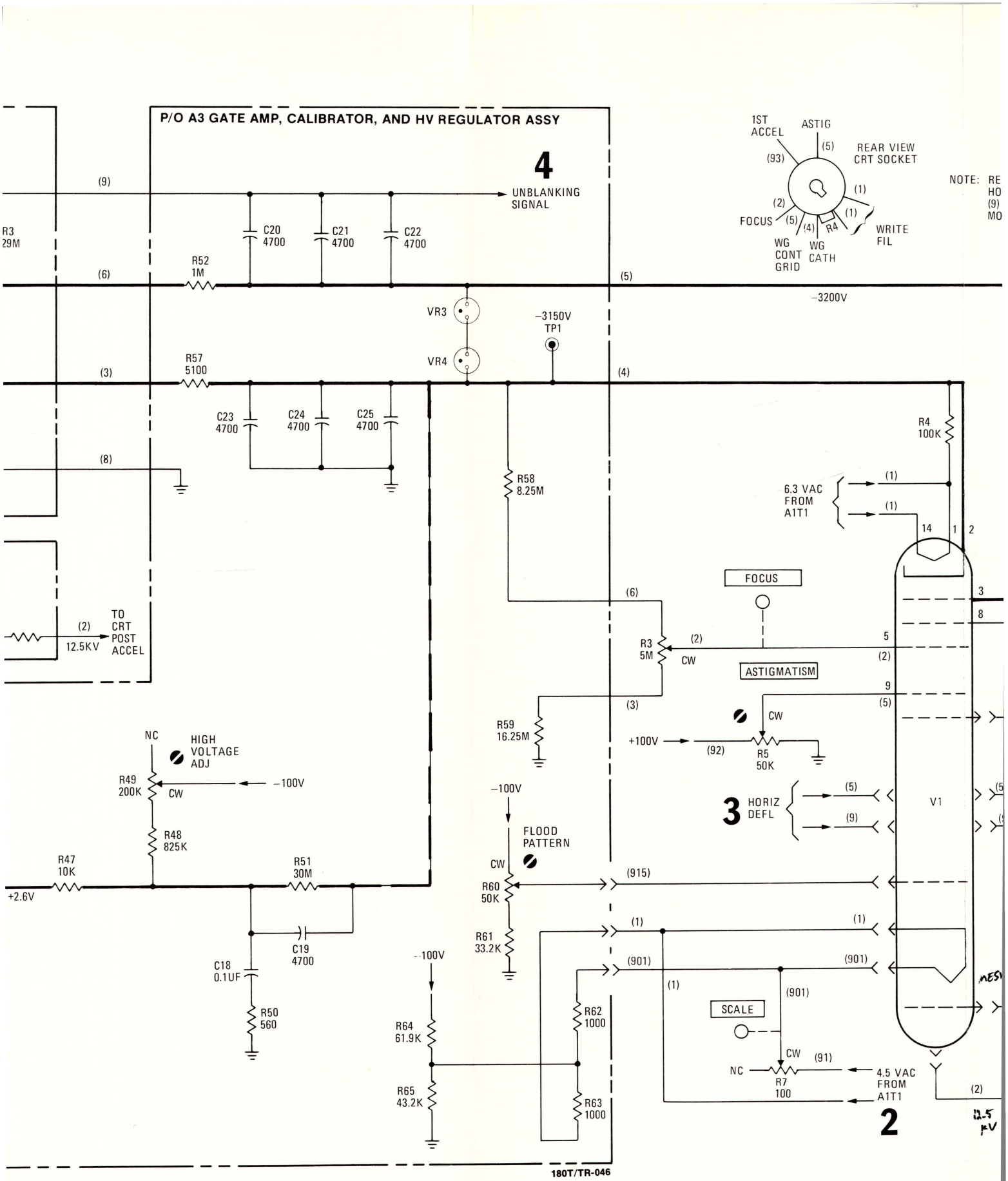
180T/TR-045

Figure 8-14. H. V. Oscillator Waveform

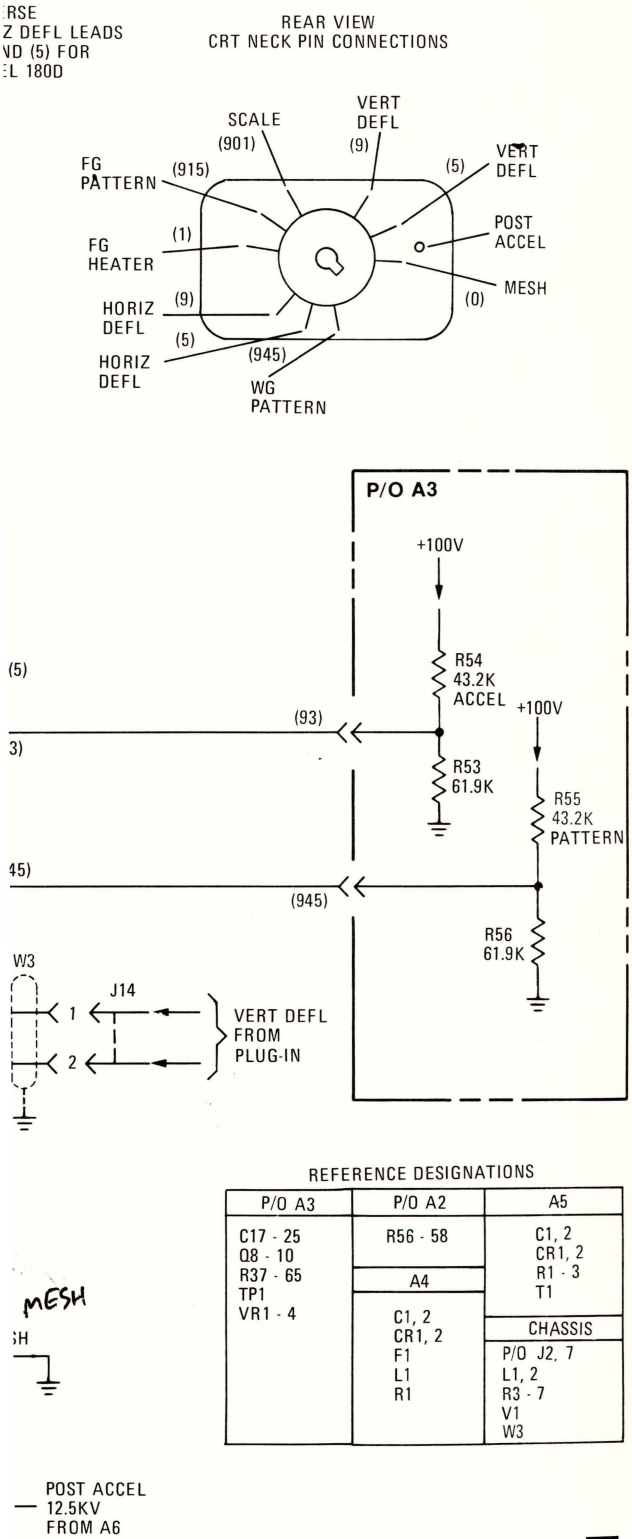
PART 10F4


A4 HV OSCILLATOR
A5 HV RECTIFIER
1
+27V UNREG
J2
3
(903)
F2 0.75A
C1 47UF
GND
4
(0)
OSCILLATOR Q1
R1 100
CR1
CR2
Q1
E
T1
D
A
C
B
R1 22K
C1 .01UF
R2 1M
CW
INTENSITY LIMIT ADJ
CR2
C2 .01UF
C2 0.22UF
L1 22
(4)
(8)
(9)
P/O A2 HORIZONTAL AMP ASSY
L1 CRT Y ALIGN
(95)
(0)
Y ALIGN
CW
−12.6V
R58 1000
R57 20K
R56 1000
+15V
A6 HV MULTIPLIER
+15VF(C)
−100V
VR1 10V
R39 511
R41 100K
R42 2000
R46 2.49K
+4.8V
Q10
+2.5V
VR2 7V
+9.5V
Q9
+2V
R38 100K
+1.8V
R40 150
+1.4V
R43 1000
Q8
+5V
R44 10K
R45 5110
REGULATOR Q8 - Q10
+15V
(902)
R6 5000
CW
L2
(957)
(956)
TRACE ALIGN
(97)
−12.6V
(0)
4
R37 2.7
C17 20UF

PART 2 OF 4


P/O A3 GATE AMP, CALIBRATOR, AND HV REGULATOR ASSY
4
UNBLANKING SIGNAL
(9)
C20 4700
C21 4700
C22 4700
R52 1M
(6)
(5)
−3200V
VR3
VR4
−3150V TP1
R57 5100
(3)
(4)
C23 4700
C24 4700
C25 4700
(8)
R58 8.25M
R4 100K
6.3 VAC FROM A1T1
(1)
(1)
14
1
2
3
8
5
(2)
TO CRT POST ACCEL
12.5KV
FOCUS
(6)
R3 5M
(2)
CW
ASTIGMATISM
9
(5)
(3)
R59 16.25M
CW
+100V
(92)
R5 50K
NC
HIGH VOLTAGE ADJ
R49 200K
CW
−100V
R48 825K
3
HORIZ DEFL
(5)
(9)
V1
−100V
FLOOD PATTERN
CW
R60 50K
(915)
R61 33.2K
(1)
(1)
R47 10K
+2.6V
R51 30M
C19 4700
C18 0.1UF
R50 560
−100V
(901)
(901)
(1)
(901)
SCALE
R64 61.9K
R62 1000
R65 43.2K
R63 1000
CW
(91)
NC
R7 100
4.5 VAC FROM A1T1
(2)
2
1ST ACCEL
ASTIG
(5)
REAR VIEW CRT SOCKET
(93)
(1)
(2)
FOCUS
(5)
(4)
R4
(1)
WRITE FIL
WG CONT GRID
WG CATH
NOTE: RE HO (9) MO
180T/TR-046

PART 3 OF 4



REFERENCE DESIGNATIONS

P/O A3	P/O A2	A5
C17 - 25 Q8 - 10 R37 - 65 TP1 VR1 - 4	R56 - 58	C1, 2 CR1, 2 R1 - 3 T1
	A4	
	C1, 2 CR1, 2 F1 L1 R1	CHASSIS
		P/O J2, 7 L1, 2 R3 - 7 V1 W3

5

Figure 8-15.
High Voltage Power Supply Schematic 5

PART 4 OF 4

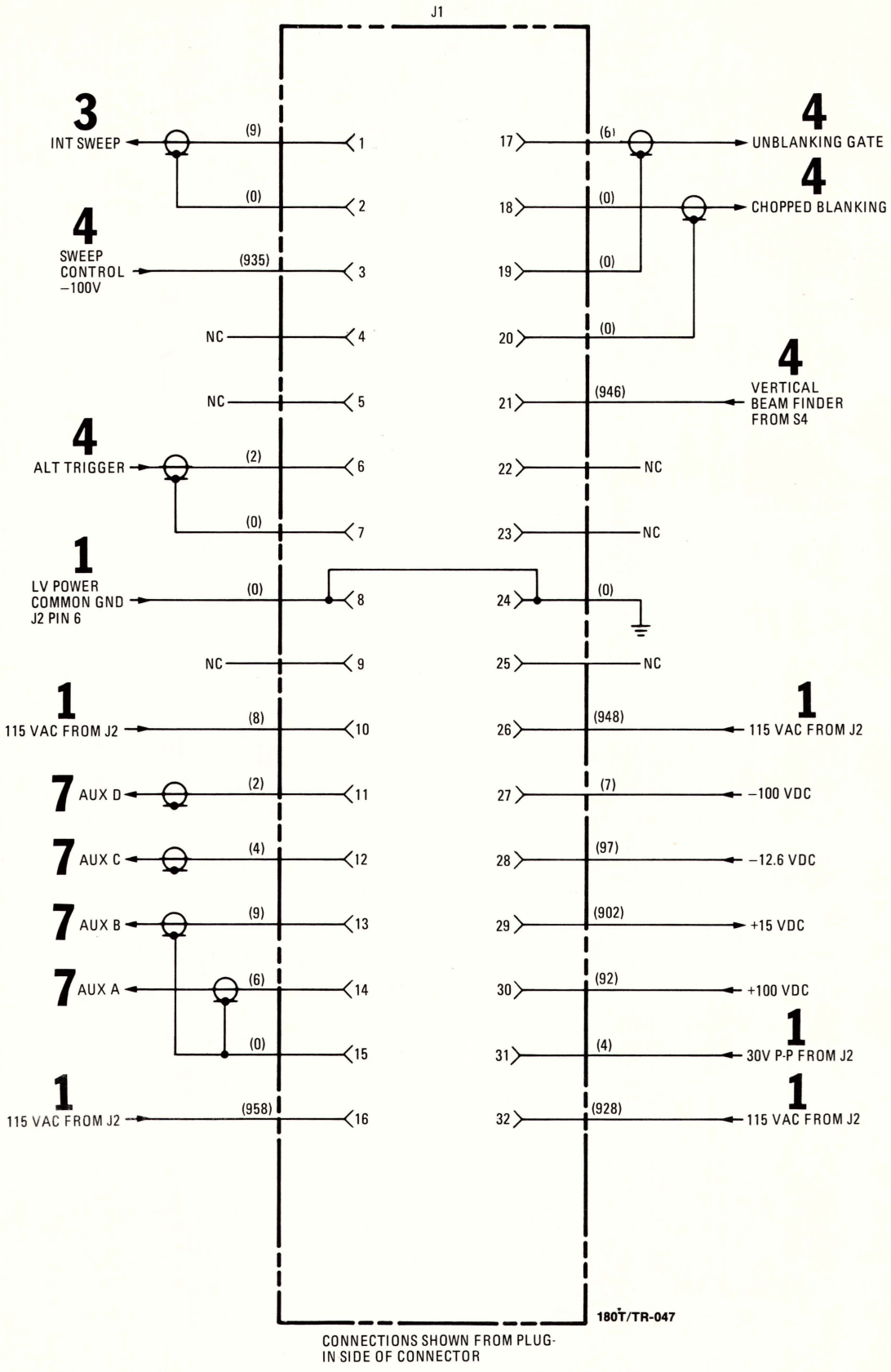


Figure 8-16. Time Base Plug-in Connections

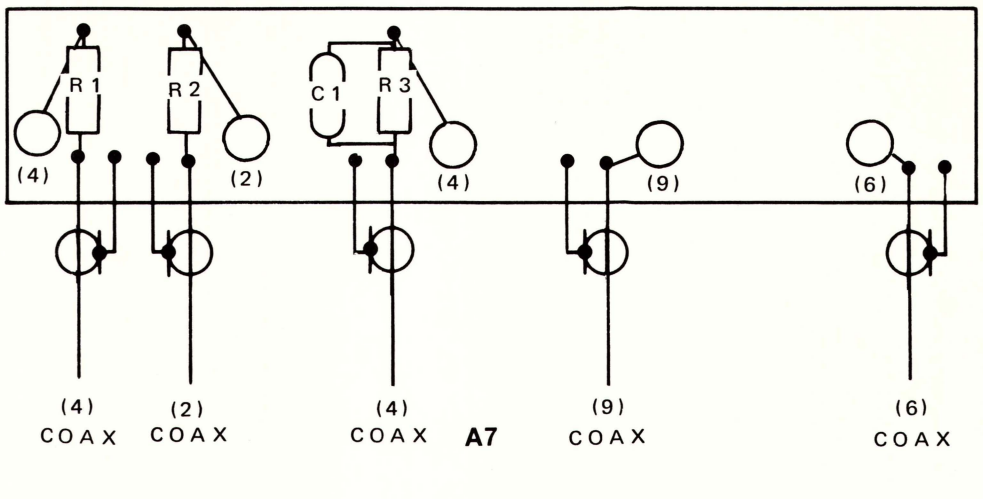


Figure 8-17. Auxiluary Output Board Component and Connection Identification

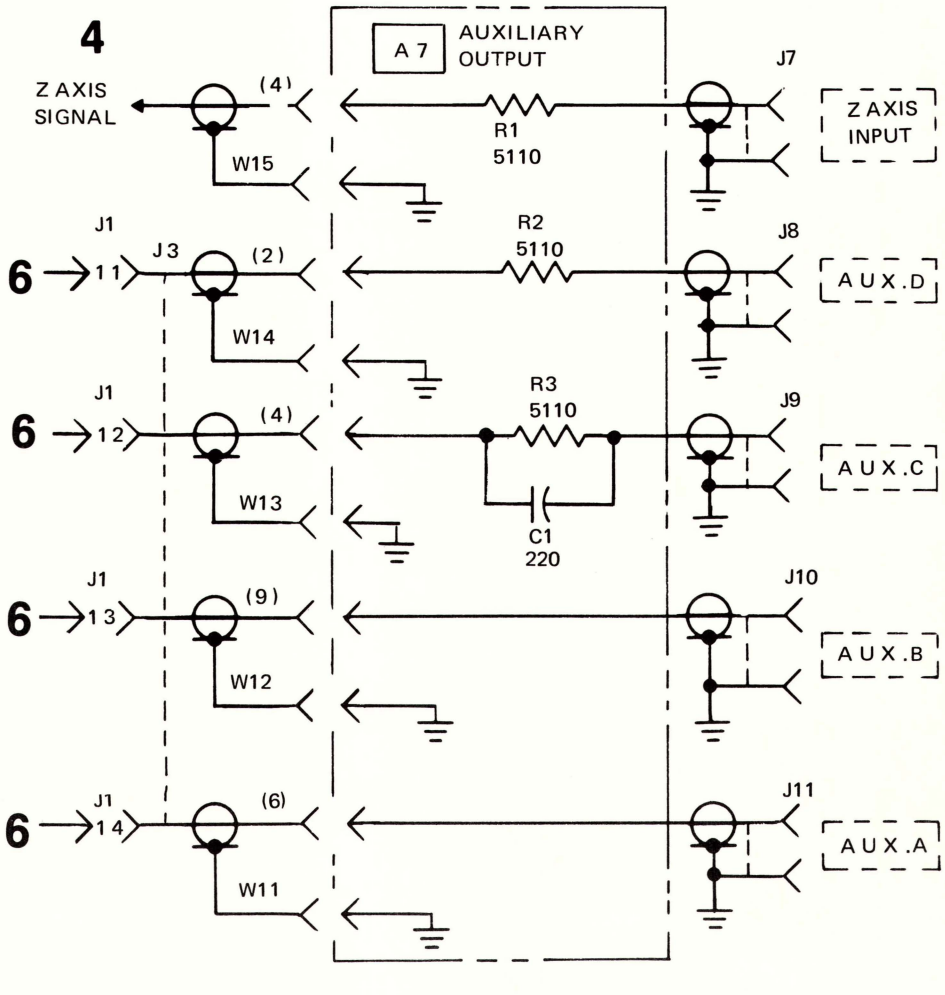


Figure 8-18.
Auxiliary Output Schematic

HEWLETT hp PACKARD

CATHODE-RAY TUBE WARRANTY AND INSTRUCTIONS

The cathode-ray tube (CRT) supplied in your Hewlett-Packard Instrument and replacement CRT's purchased from HP are warranted by the Hewlett-Packard Company against electrical failure for a period of one year from the date of sale. Broken tubes and tubes with phosphor or mesh burns are not included under this warranty. No other warranty is expressed or implied.

INSTRUCTION TO CUSTOMERS

If the CRT is broken when received, a claim should be made with the responsible carrier. All warranty claims with Hewlett-Packard should be processed through your nearest Hewlett-Packard Sales/Service Office (listed at rear of instrument manual).

INSTRUCTIONS TO SALES/SERVICE OFFICE

Return defective CRT in the replacement CRT packaging material. If packaging material is not available, contact CRT Customer Serivce in Colorado Springs. The Colorado Springs Division must evaluate all CRT claims for customer warranty, Material Failure Report (MFR) credit, and Heart System credit. A CRT Failure Report form (see reverse side of this page) must be completely filled out and sent with the defective CRT to the following address:

HEWLETT-PACKARD COMPANY
1900 Garden of the Gods Road
Colorado Springs, Colorado 80907

Attention: CRT Customer Service

Defective CRT's not covered by warranty may be returned to Colorado Springs for disposition. These CRT's, in some instances, will be inspected and evaluated for reliability information by our engineering staff to facilitate product improvements. The Colorado Springs Division is equipped to safely dispose of CRT's without the risks involved in disposal by customers or field offices. If the CRT is returned to Colorado Springs for disposal and no warranty claim is involved, write "Returned for Disposal Only" in item No. 5 on the form.

Do not use this form to accomplish CRT repairs. In order to have a CRT repaired, it must be accompanied by a customer service order (repair order) and the shipping container must be marked "Repair" on the exterior.

CATHODE-RAY TUBE FAILURE REPORT

(This form must accompany all warranty claims and MFR/HEART credit claims.)

Date _____

Submitted By (Name) _____

Name of Company _____

Address _____

1. HP Instrument Model No. _____
2. HP instrument Serial No. _____
3. Defective CRT Serial No. _____ Part No. _____
4. Replacement (New) CRT Serial No. _____
5. Please describe the failure and, if possible, show the trouble on the appropriate CRT face below.

_____

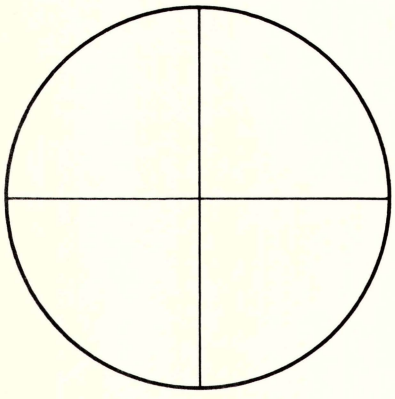
_____

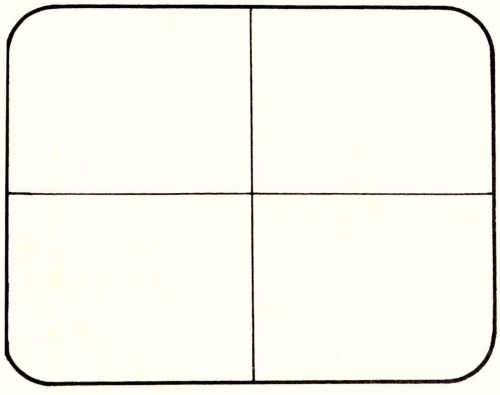
_____

_____

_____

_____





6. Type of Claim: Warranty _____ MFR. _____ HEART _____
7. HP Sales/Service Office _____ MFR/HEART or Customer Service Order No. ____

ELECTRONIC

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2336 E. Magnolia St.
Phoenix 85034
Tel: (602) 244-1361
TWX: 910-951-1330

2424 East Aragon Rd.
Tucson 85706
Tel: (602) 889-4661

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Fullerton 92631
Tel: (714) 870-1000
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TWX: 910-499-2170

6515 Arizona Place
Los Angeles 90045
Tel: (213) 776-7500
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1101 Embarcadero Road
Palo Alto 94303
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2220 Watt Ave.
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TWX: 910-367-2092

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San Diego 92123
Tel: (714) 279-3200
TWX: 910-335-2000

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Englewood 80110
Tel: (303) 771-3455
TWX: 910-935-0705

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New Haven 06525
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TWX: 710-465-2029

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P.O. Box 24210
2806 W. Oakland Park Blvd.
Ft. Lauderdale 33307
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TWX: 510-955-4099

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Orlando, 32809
Tel: (305) 859-2900
TWX: 810-850-0113

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450 Interstate North
Atlanta 30328
Tel: (404) 436-6181
TWX: 810-766-4890

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2875 So. King Street
Honolulu 96814
Tel: (808) 955-4455

ILLINOIS
5500 Howard Street
Skokie 60076
Tel: (312) 677-0400
TWX: 910-223-3613

INDIANA
3839 Meadows Drive
Indianapolis 46205
Tel: (317) 546-4891
TWX: 810-341-3263

IOWA
1902 Broadway
Iowa City 52240
Tel: (319) 338-9466
Night: (319) 338-9467

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P. O. Box 840
3239 Williams Boulevard
Kenner 70062
Tel: (504) 721-6201
TWX: 810-955-5524

MARYLAND
6707 Whitestone Road
Baltimore 21207
Tel: (301) 944-5400
TWX: 710-862-9157

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